Record of Decision
for
Operable Unit 9
Basewide Groundwater

Naval Submarine Base
New London
Groton, Connecticut

Naval Facilities Engineering Command
Mid-Atlantic
Contract Number N62467-04-D-0055
Contract Task Order 431

September 2008

TETRA TECH

PITT-10-8-016

October 9, 2008

Project Number 112G00894

NAVFAC MIDLANT, Northeast IPT
Attn: Mr. Ron Pinkoski
Bldg Z-144, 2nd Flr, Room 214
Virginia Avenue
Norfolk, Virginia 23511-3095

Reference: CLEAN Contract No. N62467-04-D-0055
Contract Task Order 431

Subject: Final Operable Unit 9 Basewide Groundwater Record of Decision
Naval Submarine Base-New London, Groton, Connecticut

Dear Mr. Pinkoski:

Please find enclosed two hard copies and two electronic copies (CDs) of the subject Record of Decision (ROD) for your records. One of the copies includes the original signature pages from the Navy and EPA. Hard copies and electronic copies of the ROD were also distributed to Mr. Richard Conant at NSB-NLON, Ms. Kymberlee Keckler at EPA Region I, Mr. Mark Lewis at CTDEP, and others, per the distribution list provided below, for their records.

The final ROD includes the page and table changes requested by EPA on September 24, 2008, signed signature pages from the EPA and Commanding Officer at NSB–NLON, and CTDEP's September 30, 2008 Concurrence Letter.

If you have any questions regarding the final ROD, please contact me at (412) 921-8984.

Sincerely,

Corey A. Rich

Corey A. Rich, P.E.
Base Coordinator/Project Manager

Enclosure(s)

c: Ms. Bonnie Capito, NAVFAC Atlantic (letter only)
Mr. Richard Conant, NSB-NLON (3 copies/3 CDs)
Ms. Kymberlee Keckler, EPA Region 1 (3 copies/3 CDs)
Mr. Mark Lewis, CTDEP (1 copy/1 CD)
Mr. Todd Finlayson, Gannett Fleming (1 copy/1 CD)
Mr. Glenn Wagner, Tetra Tech-PITT (1 copy/1 CD)
Mr. John Trepanowski, TtNUS-KOP (1 copy/1 CD)
Ms. Ralinda Miller, Tetra Tech-PITT (1 copy/1 CD)
CTO 431 – File Copy (1 copy/1 CD)

Tetra Tech NUS, Inc.
661 Andersen Drive, Pittsburgh, PA 15220-2745
Tel 412.921.7090 Fax 412.921.4040 www.ttnus.com

RECORD OF DECISION
FOR
OPERABLE UNIT 9
BASEWIDE GROUNDWATER

NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Naval Facilities Engineering Command
Mid-Atlantic
9742 Maryland Avenue
Norfolk, Virginia 23511-3095

Submitted by:
Tetra Tech NUS, Inc.
600 Clark Avenue, Suite 3
King of Prussia, Pennsylvania 19406-1433

CONTRACT NUMBER N62467-04-D-0055
CONTRACT TASK ORDER 431

SEPTEMBER 2008

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LIST OF ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
AS/SVE	Air sparging/soil vapor extraction
AST	Above-ground storage tank
Atlantic	Atlantic Environmental Services, Inc.
B&RE	Brown & Root Environmental
BGOURI	Basewide Groundwater Operable Unit Remedial Investigation
bgs	Below ground surface
CB	Chlorobenzene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Act Information System
CFR	Code of Federal Regulations
CGS	Connecticut General Statutes
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	Chemical of concern
COPC	Chemical of potential concern
CTDEP	Connecticut Department of Environmental Protection
CTE	Central tendency exposure
DCB	Dichlorobenzene
DDD	1,1-Dichloro-2,2-bis(4-chlorophenyl)ethane
DDT	1,1,1-Trichloro-2,2-bis(4-chlorophenyl)ethane
DGI	Data Gap Investigation
DRMO	Defense Reutilization and Marketing Office
EEQ	Ecological effects quotient
Envirodyne	Envirodyne Engineers, Inc.
EPA	United States Environmental Protection Agency
ERA	Ecological risk assessment
ESQD	Explosive Safety Quantity Distance
FFA	Federal Facility Agreement
FFS	Focused Feasibility Study
FS	Feasibility Study
FWEC	Foster Wheeler Environmental Corporation
GA/GAA/GB	CTDEP Groundwater Quality Classifications
GAC	Granular activated carbon
GMP	Groundwater Monitoring Plan

HCB	Hexachlorobenzene
HDPE	High-density polyethylene
HHRA	Human health risk assessment
HI	Hazard index
HQ	Hazard quotient
HSWA	Hazardous and Solid Waste Amendment
IAS	Initial Assessment Study
ICR	Incremental cancer risk
IR	Installation Restoration
LUC	Land use control
MCL	Maximum Contaminant Level
mg/kg	Milligrams per kilogram (parts per million)
mg/L	Milligrams per liter (parts per million)
NAVD	North American Vertical Datum
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEX	Naval Exchange
NFA	No Further Action
ng/kg	Nanograms per kilogram (parts per million)
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NSA	New Source Area
NSB-NLON	Naval Submarine Base New London
NTCRA	Non-Time-Critical Removal Action
NTU	Nephelometric turbidity unit
O&M	Operation and maintenance
OBDA	Overbank Disposal Area
OBDANE	Overbank Disposal Area Northeast
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PAH	Polynuclear aromatic hydrocarbon
PCB	Polychlorinated biphenyl
POTW	Publicly owned treatment works
PPE	Personnel protective equipment
PRG	Preliminary Remediation Goal
RA	Remedial action
RAB	Restoration Advisory Board
RAGS	Risk Assessment Guidance for Superfund

RAO	Remedial action objective
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RCSA	Regulations of Connecticut State Agencies
RD	Remedial Design
RfD	Reference dose
RG	Remedial goal
RI	Remedial Investigation
RME	Reasonable maximum exposure
ROD	Record of Decision
RSR	Remediation Standard Regulations (Connecticut)
SARA	Superfund Amendments and Reauthorization Act
SCS	Soil Conservation Service
SVOC	Semivolatile organic compound
SWPC	Surface water protection criterion
SwSV	Surface water screening value
TAG	Technical Assistance Grant
TAL	Target Analyte List
TBC	To Be Considered
TCE	Trichloroethene
TCL	Target Compound List
TPH	Total petroleum hydrocarbons
TSS	Total suspended solids
TtNUS	Tetra Tech NUS, Inc.
U.S.C.	United States Code
USGS	United States Geological Survey
UST	Underground storage tank
VC	Vinyl chloride
VOC	Volatile organic compound
WQS	Water Quality Standard
µg/kg	Micrograms per kilogram (parts per billion)
µg/L	Micrograms per liter (parts per billion)

GLOSSARY OF TECHNICAL TERMS

This glossary defines terms used in this Record of Decision (ROD). The definitions apply specifically to this ROD and may have other meanings when used in different circumstances.

Administrative Record File: A file that contains all information used by the lead agency to make its decision in selecting a response under CERCLA. This file is to be available for public review, and a copy is to be established at or near the site, usually at one of the Information Repositories. Also, a duplicate is filed in a central location such as a regional or state office.

Applicable or Relevant and Appropriate Requirements (ARARs): Federal environmental and state environmental and facility siting rules, regulations, statutes, and criteria that must be met by the Selected Remedy under Superfund.

Carcinogen: A substance that may cause cancer.

Chemical of concern (COC): A regulated chemical that is present at a concentration deemed to pose an unacceptable risk to human health or the environment, taking into account the acceptable level of risk land use definitions (i.e., current and reasonable potential future), and exposure scenario (i.e., completed pathways).

Chemical of potential concern (COPC): A chemical identified as a potential concern to human health or the environment through a screening-level assessment because its concentration exceeds regulatory criteria.

Comment period: A time during which the public can review and comment on various documents and actions taken either by the Navy, EPA, or CTDEP. For example, a comment period is provided when EPA proposes to add sites to the National Priorities List. A minimum 30-day comment period is held to allow community members to review the Administrative Record file and review and comment on the Proposed Plan.

Community relations: The Navy and NSB-NLON program to inform and involve the public in the Superfund process and to respond to community concerns.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601 et seq.: A federal law passed in 1980 and modified in 1986 by the Superfund Amendments and

Reauthorization Act (SARA), Public Law 99-499. The act created a special tax that goes into a trust fund to investigate and clean up abandoned or uncontrolled hazardous waste sites.

Contamination: Any physical, biological, or radiological substance or matter that, at a certain concentration, could have an adverse effect on human health and the environment.

Data Gap Investigation (DGI): A follow-up investigation performed to address data gaps identified in the results of the previous investigation.

Feasibility Study (FS): A report that presents the development, analysis, and comparison of remedial alternatives.

Five-Year Review: Review of any remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site. The review is conducted no less often than each 5 years after the initiation of the remedial action.

Groundwater: Water found beneath the earth's surface. Groundwater may transport substances that have percolated downward from the ground surface as it flows towards its point of discharge.

Hazard index (HI): Sum of the HQs for all chemicals and all routes of exposure.

Hazard quotient (HQ): The ratio of the daily intake of a chemical from on-site exposure divided by the reference dose (RfD) for that chemical. The RfD represents the daily intake of a chemical that is not expected to cause adverse health effects.

Incremental cancer risk (ICR): The incremental increase in the probability of developing cancer during one's lifetime from exposure to carcinogenic chemicals in addition to the background probability of developing cancer. The EPA ICR goal is between 1×10^{-6} (1 in a million) and 1×10^{-4} (1 in ten thousand) chance of cancer. Cancer risk less than or within the risk goal is considered an acceptable risk level by the EPA. The CTDEP ICR Guideline is 1×10^{-5} (1 in a hundred thousand) and applies to cumulative risk posed by multiple contaminants. The state's acceptable carcinogenic risk for individual pollutants is 1×10^{-6} (1 in a million).

Information Repository: A file containing information, technical reports, and reference documents regarding a Superfund site that is made available to the public.

Installation Restoration (IR) Program: The purpose of the program is to identify, investigate, assess, characterize, and clean up or control releases of hazardous substances, and to reduce the risk to human health and the environment from past waste disposal operations and hazardous material spills at Navy activities in a cost-effective manner.

Institutional controls: Institutional Controls are a subset of land use controls and are primarily legal mechanisms (non-engineering) imposed to ensure the continued effectiveness of land use restrictions imposed as part of a remedial decision. Legal mechanisms include restrictive covenants, negative easements, equitable servitudes, and deed notifications. Administrative mechanisms include notices, adopted local land use plans and ordinances, construction permitting, or other existing land use management systems that may be used to ensure compliance with use restrictions.

JP-10: A popular missile fuel which is a single-component hydrocarbon ($C_{10}H_{16}$), rather than a mixture of many hydrocarbons. JP-10 fuel is a storable liquid.

Land use controls (LUCs): Any type of physical, legal, or administrative mechanism that restricts the use of, or limits access to, real property including water resources to prevent or reduce risks to human health and the environment. Physical mechanisms encompass a variety of engineered remedies to contain or reduce contamination and/or physical barriers to limit access to property, such as fences or signs. The legal mechanisms used for LUCs are generally the same as those used for institutional controls.

Monitoring: Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, plants, and animals.

National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300: Federal regulations that provide the organizational structure and procedures for preparing for and responding to discharges of oil and release of hazardous substances, pollutants, or contaminants.

National Priorities List (NPL): The EPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial response. The list is based on the score a site receives in the Hazard Ranking System. EPA is required to update the NPL at least once a year.

Natural degradation: Natural degradation processes include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil and groundwater. These in-situ processes include biodegradation, dispersion, dilution, sorption, volatilization, and chemical or biological stabilization, transformation, or destruction of contaminants.

Operable Unit (OU): Operable units are site management tools that define discrete steps towards comprehensive actions as part of a Superfund site cleanup. They can be based on geological portions of a site, specific site problems, initial phases of action, or any set of actions performed over time or concurrently at different parts of the site.

Organic compounds: Naturally occurring or man-made chemicals containing carbon. Volatile organics can evaporate more quickly than semivolatile organics. Some organic compounds may cause cancer; however, their strength as cancer-causing agents can vary widely. Other organics may not cause cancer but may be toxic. The concentrations that can cause harmful effects can also vary widely.

Otto Fuel II: Otto Fuel II is a distinct-smelling, reddish-orange, oily liquid that the Navy uses as a fuel for torpedoes and other weapon systems. It is a mixture of three synthetic substances: propylene glycol dinitrate (the major component), 2-nitrodiphenylamine, and cibutyl sebacate and produces hydrogen cyanide when burned. Propylene glycol dinitrate, a colorless liquid with an unpleasant odor, is explosive. 2-Nitrodiphenylamine is an orange solid used to control the explosion of propylene glycol dinitrate. Dibutyl sebacate is a clear liquid used for making plastics, many of which are used for food packaging. It is also used to enhance flavor in some foods such as ice cream, candy, baked goods, and nonalcoholic drinks, and is found in some shaving creams.

Polynuclear aromatic hydrocarbons (PAHs): High molecular weight, relatively immobile, and moderately toxic solid organic chemicals featuring multiple benzenic (aromatic) rings in their chemical formula. Typical examples of PAHs are naphthalene and phenanthrene.

Proposed Plan: A public participation requirement of SARA in which the lead agency summarizes for the public the preferred cleanup strategy and the rationale for preference and reviews the alternatives presented in the detailed analysis of the FS. The Proposed Plan may be prepared either as a fact sheet or as a separate document. In either case, it must actively solicit public review and comment on all alternatives under consideration.

Record of Decision (ROD): An official document that describes the selected Superfund remedy for a site. The ROD documents the remedy selection process and is issued by the Navy and EPA following the public comment period.

Remedial Investigation (RI): A report that describes the site, documents the nature and extent of contaminants detected at the site, and presents the results of the risk assessment.

Remedial action: The actual construction or implementation phase that follows the remedial design for the selected cleanup alternative at a site on the NPL.

Response action: As defined by CERCLA Section 101(25), response actions include removal or remedial actions, including enforcement activities.

Responsiveness Summary: A summary of written and oral comments received during the public comment period, together with the Navy's and EPA's responses to these comments.

Risk assessment: Evaluation and estimation of the current and future potential for adverse human health or environmental effects from exposure to contaminants.

Site Use Restrictions document: SOPA (ADMIN) New London Instruction 5090.18D, Installation Restoration Site Use Restrictions at Naval Submarine Base New London defines Navy policy and procedures regarding disturbance of contaminated soil/sediment and/or extraction of contaminated groundwater. The locations of impacted media are also identified in figures provided in the Instruction.

Source: Area(s) of a site where contamination originates.

Superfund: The trust fund established by CERCLA that can be drawn on to plan and conduct cleanups of past hazardous waste disposal sites and current releases or threats of releases of non-petroleum products. Superfund is often divided into removal, remedial, and enforcement components.

Superfund Amendments and Reauthorization Act (SARA): The public law enacted on October 17, 1986, to reauthorize the funding provisions and amend the authorities and requirements of CERCLA and associated laws. Section 120 of SARA requires that all federal facilities be subject to and comply with this act in the same manner and to the same extent as any non-government entity.

TH Dimer: Tetrahydromethylcyclopentadiene, also called RJ-4, is a fuel developed for ram-jet missiles. It has been used for the Navy Sea Launched Cruise Missile. It can be used alone or blended with other fuels (e.g., a component of JP-9 jet fuel).

1.0 DECLARATION

1.1 SITE NAME AND LOCATION

This Final Record of Decision (ROD) includes the groundwater at the following sites:

- Site 2A - Area A Landfill
- Site 2B - Area A Wetland
- Site 3 - Area A Downstream Watercourses and Overbank Disposal Area (OBDA)
- Site 7 - Torpedo Shops
- Site 9 - Waste OT-5
- Site 14 - Overbank Disposal Area Northeast (OBDANE)
- Site 15 - Spent Acid Storage and Disposal Area
- Site 18 - Solvent Storage Area, Building 33
- Site 20 - Area A Weapons Center
- Site 23 - Tank Farm

These sites comprise the Basewide Groundwater Operable Unit (OU) 9.
Naval Submarine Base – New London (NSB-NLON)
Groton, Connecticut
CERCLIS ID No. CTD980906515

1.2 STATEMENT OF BASIS AND PURPOSE

This Final ROD for OU9 presents the Selected Remedies for the groundwater at Sites 2A, 2B, 3, 7, 9, 14, 15, 18, 20, and 23 at NSB-NLON, Groton, Connecticut. Sites 2A, 2B, 3, 7, 14, and 20 are located in the northern portion of NSB-NLON in close proximity to each other, and the groundwater beneath these sites is hydraulically connected. Sites 9, 15, 18, and 23 are located in the southern portion of NSB-NLON in close proximity to each other, and the groundwater beneath these sites is hydraulically connected. Groundwater at Sites 9, 15, 18, and 23 is also included in OU9. The Selected Remedies were chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 United States Code (U.S.C.) 9601 et seq., as amended by the Superfund Amendments and Reauthorization Act (SARA), Public Law 99-499, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300. These decisions are based on information contained in the Administrative Record file for these sites.

The United States Department of the Navy and the United States Environmental Protection Agency (EPA) Region I issue this Final ROD jointly. The State of Connecticut Department of Environmental Protection (CTDEP) concurs with the Selected Remedies (see Appendix A).

1.3 ASSESSMENT OF SITE

The remedial actions (RA) selected in this Final ROD for Sites 3, 7, 9, and 23 groundwater are necessary to protect public health or welfare or the environment from actual or threatened releases of pollutants or contaminants from these sites.

The Navy has determined that No Further Action (NFA) is necessary for the groundwater at Sites 14, 15, 18, and 20 to protect public health or welfare or the environment. Groundwater at Sites 2A and 2B is currently monitored under a groundwater monitoring program selected as part of the remedy for OU1. Institutional controls, required under the OU1 ROD, will remain in place at Sites 2A and 2B as described in the Site Use Restrictions document.

1.4 DESCRIPTIONS OF SELECTED REMEDIES

A total of 12 OUs have been defined at NSB-NLON to address the 23 sites included in the NSB-NLON Installation Restoration (IR) Program. This Final ROD only applies to the Basewide Groundwater OU9, which includes groundwater at Sites 2A, 2B, 3, 7, 9, 14, 15, 18, 20, and 23. Before final remedies were chosen for Sites 2A, 2B, 9, and 23, an Interim ROD was signed to document selection of interim remedies for groundwater at the remaining OU9 sites (Navy, 2004e). This ROD documents the final actions for all of OU9.

The Selected Remedies for groundwater at Sites 3 and 7 and Sites 9 and 23 require the development and implementation of response measures that will protect human health and the environment from contaminated groundwater at these sites. NFA is necessary for groundwater at Sites 14, 15, 18, and 20. Groundwater monitoring and institutional controls will continue at Sites 2A and 2B as part of the OU1 remedy. The soil at Site 2 (OU1), Site 3 (OU3), Site 3 – New Source Area (NSA), Site 7 (OU8), Site 14 (OU8), Site 15 (OU6), Site 18 (a portion of OU11), and the soil and sediment at Site 20 (OU7) were addressed in separate RODs or other decision documents.

1.4.1 Sites 3 and 7

The final Selected Remedy for groundwater at Sites 3 and 7 is Institutional Controls with Monitoring. The Selected Remedy complies with regulatory requirements and includes the following major components:

- Continuation of institutional controls that identify the location and magnitude of groundwater contamination, restrict extraction and use of the groundwater, and control vapor intrusion (Site 3 only) based on land use. Institutional controls were initially implemented at Sites 3 and 7 in December 2006 in accordance with the Interim ROD. These interim controls are incorporated into this Final ROD. In the event of property transfer and with confirmation that contaminated groundwater remains at the sites, an environmental land use restriction pursuant to state law will be used to prohibit the use of groundwater.

- Continued monitoring of the degradation and potential migration of groundwater contaminants until concentrations decrease to levels at which unrestricted use of and unlimited exposure to groundwater may be permitted. The monitoring program at Sites 3 and 7 was initiated in May 2006 in accordance with the Interim ROD.

- Five-year reviews until the results of the monitoring program indicate that remedial goals have been reached.

1.4.2 Sites 9 and 23

The final Selected Remedy for groundwater at Sites 9 and 23 is Institutional Controls [SOPA (ADMIN) New London Instruction 5090.18D (Appendix B)]. The Selected Remedy complies with regulatory requirements and involves implementation of institutional controls that identify the location and magnitude of groundwater contamination and restrict extraction and use of the groundwater. In the event of property transfer and with confirmation that contaminated groundwater remains at the sites, an environmental land use restriction pursuant to state law will be used to prohibit the use of groundwater. Five-year reviews will be conducted until contaminant concentrations are shown to be protective of human health and the environment.

1.4.3 Sites 2A, 2B, 14, 15, 18, and 20

Groundwater at Sites 14, 15, 18, and 20 poses no current or future potential threat to human health or the environment; therefore, NFA is the Selected Remedy and the Navy will not implement any treatment, engineering controls, or institutional controls at these sites.

At Sites 2A and 2B, groundwater monitoring as described in the OU1 ROD (Navy, 1995) and institutional controls as described in the NSB-NLON IR Site Use Restrictions document will continue. No additional action is required under OU9 to address groundwater at these sites.

1.5 STATUTORY DETERMINATIONS

The final remedies for Sites 2A, 2B, 3, 7, 9, 14, 15, 18, 20, and 23 groundwater are protective of human health and the environment, comply with federal and state requirements that are applicable or relevant and appropriate to the remedial actions, and are cost effective.

The Selected Remedies for groundwater at Sites 3 and 7 and Sites 9 and 23 do not satisfy the statutory preference for treatment as a principal element of the remedy. Due to the sporadic and relatively low concentrations of contaminants in groundwater, the Navy has determined that incorporating technologies to actively reduce the toxicity of the contaminants on site would not be cost effective. Treatment is not necessary for groundwater at Sites 2A and 2B based on the OU1 ROD or at Sites 14, 15, 18, and 20 because the Selected Remedy is NFA.

Because the Selected Remedies will result in contaminants remaining on site in excess of remedial goals, institutional controls will be implemented to prevent exposure to contaminated groundwater and to ensure that the RAOs are achieved. The Selected Remedies for Sites 3 and 7 and Sites 9 and 23 will result in contaminants remaining in groundwater at the sites at concentrations that do not allow for unrestricted use and unlimited exposure; therefore, statutory reviews will be conducted within 5 years of initiation of remedial action, and every 5 years thereafter, to ensure that the remedies continue to protect human health and the environment. If the remedies are determined not to be protective of human health and the environment because the institutional controls have failed, the Navy will be required to undertake additional remedial action.

The selection of NFA remedies for groundwater at Sites 14, 15, 18, and 20 is based on investigation and risk assessment results indicating that no additional remedial actions are necessary to ensure protection of human health and the environment. Because the remedies will not result in hazardous substances, pollutants, or contaminants remaining on site in excess of levels that allow for unlimited use and unrestricted exposure, five-year reviews of these sites as part of OU9 will not be required. Five-year reviews of Sites 2A and 2B will continue under OU1.

1.6 ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this ROD:

- Chemicals of concern (COCs) and their respective concentrations.

- Baseline risk represented by the COCs.

- Cleanup levels (i.e., remedial goals) established for COCs and the basis for these levels.
- If present, how source materials constituting principal threats would be addressed.
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessments and ROD.
- Potential land and groundwater uses that will be available at the sites as a result of the Selected Remedies.
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rates, and the number of years over which the remedy cost estimates are projected.
- Key factor(s) that led to selecting the remedies (i.e., description of how the Selected Remedies provide the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision).

Additional information can be found in the Administrative Record file for Sites 2A, 2B, 3, 9, 7, 14, 15, 18, 20, and 23.

1.7 AUTHORIZING SIGNATURES

The signatures provided on the following pages validate the selection of the final remedies for groundwater at OU9, Sites 2A, 2B, 3, 9, 7, 14, 15, 18, 20 and 23 by the Navy and EPA. CTDEP concurs with the Selected Remedies.

Concur and recommend for implementation:

24SEPT 2008

Mark S. Ginda, USN
Naval Submarine Base - New London

Date

Concur and recommend for implementation:

fa

James T. Owens, III, Director
Office of Site Remediation and Restoration
EPA Region I

9-30-08
Date

2.0 DECISION SUMMARY

This ROD describes the remedies selected by the Navy and EPA for OU9, Sites 2A, 2B, 3, 7, 9, 14, 15, 18, 20, and 23 groundwater to protect human health and the environment. The Navy is the lead agency for CERCLA activities at NSB-NLON and provides the funding for the cleanup activities. EPA provides the primary regulatory oversight and enforcement for CERCLA activities at NSB-NLON, and CTDEP is also actively involved in supporting the activities as required under the Federal Facility Agreement (FFA) (EPA, 1995).

2.1 SITE NAME, LOCATION, AND BRIEF DESCRIPTION

NSB-NLON is located in southern Connecticut in the Towns of Ledyard and Groton. NSB-NLON is situated on the eastern bank of the Thames River, approximately 6 miles north of Long Island Sound. It is bordered on the east by Connecticut Route 12, on the south by Crystal Lake Road, and on the west by the Thames River. The northern border is a low ridge that trends approximately east-southward from the Thames River to Baldwin Hill. A general facility location map is presented as Figure 2-1. The location of each IR Program site within NSB-NLON is shown on Figure 2-2.

2.1.1 <u>Site 2A – Area A Landfill and Site 2B – Site A Wetland</u>

Site 2 is located in the northeastern and north-central portions of NSB-NLON and includes Site 2A, the Area A Landfill, and Site 2B, the Area A Wetland. The Area A Landfill encompasses approximately 13 acres and is a relatively flat area bordered by a steep, wooded hillside that rises to the south, a steep wooded ravine to the west, and the Area A Wetland to the north. The general configuration of Site 2 and adjacent areas is shown on Figure 2-3.

The Area A Landfill opened around 1957. Incinerated combustible wastes were disposed at the site until 1963, followed by refuse and debris disposal until 1973, when landfilling operations ceased. The thickness of landfill materials is estimated to range from 10 to 20 feet. After closure, a concrete pad was constructed on a portion of the landfill. In the early 1980s, transformers and electrical switches stored on the pad were reported to be leaking. Petroleum compounds were poured from containers at the landfill and flowed into the Area A Wetland. Spent sulfuric acid solution from batteries was poured into trenches dug into the Area A Landfill for disposal and subsequently covered with soil.

The location of the Area A Wetland was undeveloped wooded land and possibly wetland until the late 1950s when dredge spoils from the Thames River were pumped to the Area A Wetland and contained within an earthen dike that extends from the Area A Landfill to the southern side of the Area A Weapons

Center. The thickness of dredge spoils ranges from 35 feet to 10 feet. A small pond is located at the southern portion of the wetland, within which 1 to 3 feet of standing water is present during all seasons. Phragmites is the predominant type of vegetation. It was reported that formulated (water-soluble) 1,1,1-trichloro-2,2-bis(4-chlorphenyl)ethane (DDT) was used in this area in the 1960s prior to the 1972 ban on DDT. The Area A Wetland encompasses approximately 26 acres.

2.1.2 Site 3 – Area A Downstream Watercourses and OBDA

Site 3 is located in the northern portion of NSB-NLON and includes undeveloped wooded areas featuring several small ponds, streams, and wetlands and recreation areas (golf course and lake for swimming). Site 3 covers approximately 75 acres. Site 3 receives surface water and groundwater recharge from the Area A Landfill (Site 2A), Area A Wetland (Site 2B), Site 7, Site 14, and surrounding areas and convey them to the Thames River. Site 3 includes North Lake and several small ponds (Upper Pond, Lower Pond, and OBDA Pond) and interconnected streams (Streams 1 through 6). The major sources of contamination to Site 3 included historical application of pesticides, abandoned disposal areas, and the septic system leach fields at Site 7. The general configuration of Site 3 and adjacent areas is shown on Figure 2-4.

The primary discharge points from Site 2B to Site 3 are through four 24-inch-diameter metal culvert pipes located within the dike that separates Site 2B from Site 3. The discharge from these culverts forms a small stream (Stream 4) that flows westward for approximately 200 feet into Upper Pond. Upper Pond discharges to Stream 3, which flows northward and then westward toward Triton Road (past the OBDANE site) to the entrance of Site 7. At this location, it meets the drainage channel from Site 7 and forms Stream 5. Stream 5 flows westward along Triton Road through the Small Arms Range, under Shark Boulevard, and eventually discharges to the Thames River at the Defense Reutilization and Marketing Office (DRMO) outfall. Upper Pond also has a discharge structure on the southern side. A second pond (Lower Pond), northwest of Upper Pond, is a natural depression and is recharged by groundwater inflow. The outlet of the pond forms Stream 2, which enters a storm sewer and flows to the west around North Lake.

Groundwater discharges from Site 2A to a small pond (the OBDA Pond) located at the base of the dike and the OBDA. Stream 1 flows from this pond westward toward North Lake, a recreational swimming area for Navy personnel. Under normal flow conditions, the stream enters a culvert that bypasses North Lake and discharges to a stream (Stream 6) below the outfall of the lake. Stream 6, which is formed by Stream 1, Stream 2, and the outflow of North Lake, flows westward under Shark Boulevard and through the golf course to the Thames River. North Lake is filled with potable water every year and drained at the end of the season. Surface water levels in North Lake do not appear to coincide with groundwater levels in adjacent monitoring wells, indicating little hydraulic connection between surface water of North Lake and the shallow groundwater.

A nine-hole golf course covers a majority of the western portion of Site 3. It was reported that groundwater wells were used to provide irrigation water for the golf course until the early 1980s. These wells were eliminated, and municipal potable water is currently used for irrigation purposes.

Most of Site 3 is within designated Explosive Safety Quantity Distance (ESQD) arcs of Site 20; therefore, further development is not planned for this area. Navy regulations prohibit construction of inhabited buildings or structures within these arcs and, although existing buildings operate under a waiver of these regulations, no further construction is planned.

2.1.3 Site 7 – Torpedo Shops

Site 7 is located in the northern portion of NSB-NLON on the northern side of Triton Road. Figure 2-5 shows the general site arrangement. The site is bordered on the east and north by 60-foot-high bedrock cliffs. The remainder of the site slopes to the southwest towards Site 3. An earthen berm extends along the base of the eastern portion of the exposed rock face. Four buildings (325, 450, 477, and 528) exist at the site.

Building 325 is a torpedo overhaul facility. A variety of fuels, solvents, and petroleum products have been used in Building 325 including Otto Fuel II [which is comprised of propylene glycol dinitrate (76 percent), 2-nitrodiphenylamine (1.5 percent), and di-n-butyl sebacate (22.5 percent) and produces hydrogen cyanide when burned], high-octane alcohol (190-proof grain alcohol), and TH-Dimer (jet rocket fuel). Solvents including mineral spirits, alcohol, and 1,1,1-trichloroethane and petroleum products such as motor oil and grease were also used in this building. A sink in one area was previously used for film development, and another sink was used for the overhaul of alkaline batteries. This plumbing drained into the on-site septic system until 1983. A maintenance area has a shallow sump covered with flush-mounted steel grating. The area surrounding this sump was previously a washdown/blowdown area for weapons. It is not known where this sump drains, although it may drain into the south leach field. Two underground and one above-ground storage tanks were located on the southern side of Building 325 and used to store fuel oil.

A smaller building attached to the eastern side of Building 325 was previously used as an assembly shop for torpedoes and as a paint shop. A closet in this building was used to store containers of 1,1,1-trichloroethane and methyl ethyl ketone (2-butanone). Drums and cylinders were stored outside on the eastern side of this building. The vessels were labeled as containing propane, isobutane, 2-butanone, xylot, methylene chloride, propellant, and zinc chromate. An addition to the northern side of Building 325, completed in 1990, is also used as a torpedo maintenance shop.

Building 450 is the primary MK-48 torpedo overhaul/assembly facility. Petroleum products including TL-250 motor oil and hydraulic fluid have also been used in this building for torpedo maintenance. Torpedo overhaul/assembly operations at Building 450 generate fuels, solvents, and petroleum products as wastes. An Otto fuel and seawater mixture is drained from the torpedoes and replenished with fresh fuel. The Initial Assessment Study (IAS) Report [Envirodyne Engineers, Inc. (Envirodyne), 1983] indicated that Building 450 generates approximately 3,000 gallons of Otto fuel wastewater per month. This building was constructed with a waste collection system that collected waste products from floor drains and discharged them to an underground waste tank/sump with a capacity of approximately 1,500 gallons. The waste tank was pumped periodically and the contents were disposed off site. Otto fuel product was previously stored in a 4,000-gallon underground tank south of Building 450. The hazardous waste sump was decommissioned in 1987. It was replaced with three 1,000-gallon above-ground tanks located south of the building. The floor drains were sealed and replaced with a new system for pumping waste products to the new tanks. A 4,000-gallon above-ground Otto fuel storage tank replaced the previous tank and is located south of the building.

Building 477, approximately 65 feet east of Building 450, was formerly used to store drums of Otto fuel. Solvents including 1,1,1-trichloroethane, trichloroethene (TCE), toluene, mineral spirits, alcohol, and bulk Freon have been used at this facility.

2.1.4 Site 9 – Waste OT-5

Site 9 included OT-5, a former underground concrete storage tank, located within Site 23 (see Section 2.1.9 and Figure 2-6). The soil at Site 9 was investigated and remediated and a corrective action was completed under the CTDEP RCRA UST Program; therefore, no decision documents were required or prepared for Site 9 soil. The tank was constructed in the 1940s and was used to store fuel oil. The tank had a capacity of approximately 750,000 gallons. In the late 1970s, the tank was converted to a storage tank for bilge water and other waste solutions. Use of OT-5 was discontinued in 1993, and all tank contents were removed. A residual sludge layer of approximately 2 to 3 inches was left in the tank during purging. This sludge contained polychlorinated biphenyls (PCBs) at concentrations exceeding 500 mg/kg. After OT-5 was emptied, groundwater infiltrated through cracks in the concrete surface and partially refilled the tank. Residual materials were removed in 1994. After the contents of OT-5 were removed, the tank was cleaned and the top of the tank was crushed. The tank was closed in place by filling it with inert material. Because Site 9 is located within the site boundaries of Site 23, Site 9 groundwater was evaluated and is being addressed with Site 23 groundwater.

2.1.5 Site 14 – OBDANE

Site 14 is located between Sites 7 and 20 in a wooded area on the edge of a ravine just north of Stream 3 in Site 3 (see Figure 2-4). Miscellaneous wastes were dumped at the site in the past. Historical reports state that the vegetation at the site indicated that no dumping had occurred within 10 years prior to 1982. Inspection of the site verified the presence of several empty fiber drums. No visual soil staining or stressed vegetation was observed. The site was circular and approximately 80 feet in diameter. A dirt road provides limited access to the site. A nearly vertical 20-foot-high bedrock face is located at the eastern edge of the site. The rest of the site slopes to the southwest.

2.1.6 Site 15 – Spent Acid Storage and Disposal Area

Site 15 is located in the southern portion of NSB-NLON and was used before and after World War II for the temporary storage of waste battery acid in a rubber-lined underground tank located between the southern sides of Buildings 409 and 410. The site location and historical and recent sampling locations are shown on Figure 2-7. The site's location relative to other IR Program sites is depicted on Figure 2-2.

2.1.7 Site 18 – Solvent Storage Area, Building 33

Site 18 consists of Building 33, the Solvent Storage Area. The building was used for the storage of gas cylinders and 55-gallon drums of solvents. The location of Building 33 is shown on Figure 2-2 and Figure 2-8.

2.1.8 Site 20 – Area A Weapons Center

Site 20 consists of Building 524 and the weapons storage bunkers. The storage bunker area is divided into two portions (north and south areas) that were constructed at different times and are of different design. The site is located at the eastern end of Triton Road, adjacent to the northern side of the Site 2B. The general configuration of Site 20 is shown on Figure 2-9.

Site 20 is located near the top of a local topographic and bedrock high. Building 524 was constructed in 1990 and 1991. Portions of the site were blasted to remove bedrock to accommodate construction of the building. The weapons storage bunkers are located southeast and downhill of Building 524 and are adjacent to and at a slightly higher elevation than the Area A Wetland.

Building 524 is used for administration, minor torpedo assembly, and storage of simulator torpedoes. No weapons production takes place in this building. Small quantities of chemicals and chemical waste generated by activities in this building are stored in 1- to 5-gallon containers in seven metal storage cabinets located on a paved area south of the building. The chemicals include cleaning and lubricating compounds, paints, and adhesives. Many of these materials are classified as corrosive or flammable.

Liquid fuels present in the weapons storage bunkers include Otto fuel, JP-10, and TH Dimer (jet rocket fuel). The group of southern area bunkers was reconstructed in the last 15 years. A major part of the reconstruction involved removal of structurally unsuitable soil from the site.

2.1.9 Site 23 – Tank Farm

Site 23, Tank Farm, is located in the southern portion of NSB-NLON and includes nine former USTs that were demolished and closed in place, a 30,000-gallon, double-walled UST (OT-10), a 10,000-gallon waste oil tank, a fuel oil loading area, a tanker truck dumping pad and trough, associated UST piping systems, baseball/softball fields, buildings that housed the former air sparging/soil vapor extraction (AS/SVE) facility for the Naval Exchange (NEX) service station, two 150,000-gallon diesel above-ground storage tank (ASTs), and other buildings. The general configuration of Site 23 is shown on Figure 2-6.

Each of the nine USTs had a holding capacity of 750,000 gallons. No. 6 fuel oil was stored in tanks OT-1 through OT-3 from the date of construction until they were removed from service in the summer of 1991. Tanks OT-7 through OT-9 were decommissioned in the summer of 1990 and were used exclusively for storage of diesel during all 48 years of service. A reduced demand for diesel fuel at NSB-NLON in the mid-1970s led to the decommissioning and demolition of tank OT-6. The reduced demand for diesel also led to the modification of tank OT-5 for waste oil storage purposes. Tank OT-4 was used to store tank bottom wastes from OT-1. Tank OT-5 was used as part of an oil/water separator system (see Site 9 discussion below). Tanks OT-4 and OT-5 were reportedly decommissioned after installation of a new 30,000-gallon waste oil underground tank (OT-10) in 1990. Tanks OT-1 through OT-9 have been demolished and closed in place. A number of petroleum releases were documented by the Navy in the vicinity of the Tank Farm, and evidence of releases of petroleum products from these tanks, their associated piping, and possibly from other nearby sources was detected during previous investigations.

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.2.1 Site History

2.2.1.1 Site 2

Site 2A

A Phase I Remedial Investigation (RI) (Atlantic, 1992), Focused Feasibility Study (FS) (FFS) (Atlantic, 1995b) and Phase II RI (B&RE, 1997) were conducted for the Site 2A, Area A Landfill. The Phase II RI concluded that shallow groundwater contamination existed at the site, that the landfill soil may pose a threat to human receptors due to concentrations of PCBs, and that chemicals in soil could adversely impact ecological receptors. To address Site 2A soil (OU1), an RA that involved the construction of a 13-acre low-permeability cover system over the landfill area was performed in 1997. The groundwater at the Area A Landfill is currently being monitored as part of the OU1 compliance monitoring program. Groundwater at the site was also investigated as part of the BGOURI (TtNUS, 2002a), which recommended that the monitoring program be continued to gather data to evaluate long-term trends in contaminant concentrations and the decision to proceed to an FS should be made after sufficient data have been collected and evaluated. Land use controls (LUCs) have been implemented at the landfill to meet the requirements in the soil ROD. A majority of the Area A Landfill is paved and is currently used for storage of equipment and vehicles.

The initial Groundwater Monitoring Plan (GMP) (TtNUS, 1999) for Site 2 called for monitoring groundwater and surface water for semivolatile organic compounds (SVOCs), volatile organic compounds (VOCs), polynuclear aromatic hydrocarbons (PAHs), metals, pesticides/PCBs, and various field parameters. After 4 years of monitoring, the monitoring program was revised to discontinue monitoring for VOCs, pesticides, and PCBs because no exceedances of these compounds were detected in 4 years.

Site 2 has now been monitored for 8 years. The most recent results available, those from Year 7 (2006), determined that the only contaminant detected in groundwater in excess of criteria is copper, and this was in a reference well, not a downgradient well. Overall, the results of 8 years of monitoring indicate that the cap system is working properly and that significant contaminant migration from the site to surrounding areas is not occurring.

Site 2B

The Phase I and II RIs (1992 and 1997, respectively) and the BGOURI (2002) included investigations of the Site 2B, Area A Wetland. Area A Wetland sediment was identified as OU12 and is still being investigated under CERCLA.

A phased RI was conducted to determine the nature and extent of contamination at the Area A Wetland. The Phase I RI field conducted from 1990 to 1992 (Atlantic, 1992) concluded that risks associated with several exposure scenarios exceeded acceptable regulatory levels and that an FS should be performed for the Area A Wetland site. The Phase II RI (B&RE, 1997) concluded that little surface water or groundwater contamination exists at the site, that the site may pose a risk to a construction worker due to potential exposure to manganese in the groundwater, and that significant pesticide, PCB, and PAH concentrations exist in site soil and sediment. The Phase II RI recommended that an FS should be conducted for this site to evaluate a limited action alternative including groundwater monitoring and access/use restrictions.

A Phase III investigation of the sediments at the Area A Wetland was conducted in October 2007. The major objectives of the investigation were to further refine the nature and extent of contamination in sediments and to provide sufficient data to determine potential risks to ecological receptors from contaminated sediments. A secondary objective of the investigation was to determine the thickness of the overlying organic layer that has formed above the dredge spoils. The evaluation of the investigation results was ongoing at the time of preparation of this ROD; therefore, no conclusions from the investigation were available.

Groundwater at the Area A Wetland is currently being monitored under the Area A Landfill long-term groundwater monitoring program (OU1).

2.2.1.2 Site 3

Site 3, Area A Downstream Watercourses, covers approximately 75 acres and contains mainly undeveloped wooded areas and recreational areas. The Site 3 watercourses include several small ponds and interconnected streams (Figure 2-4) that convey surface water to the Thames River. The major sources of contamination at Site 3 include historical application of pesticides for mosquito control, abandoned disposal areas, and the septic system leach fields at Site 7. There are relatively few buildings (Buildings 223, 281, 282, 376, 454, and 468) at Site 3. Most of these buildings are associated with the recreational area at North Lake and the golf course, which comprises a large portion of the site area. Further development is not planned for this area because most of it is within designated ESQD arcs of Site 20.

An earthen dike was constructed in 1957 in the area between Sites 2 and 3. The valley on the eastern side of the dike was filled with dredge spoils from the Thames River, which created Site 2B. The Site 3 ponds were created to act as settling ponds for any dredge spoil that was discharged from the Site 2B.

Site 3 also included the OBDA. The OBDA was located on the slope of the dike below and adjacent to the Area A Landfill. It was located on the southwestern end of the dike, and a small wetland exists at the base of the dike. The OBDA was used as a disposal site after the earthen dike was constructed in 1957. Materials disposed at the site included thirty 200-gallon metal fuel tanks (unlabeled), scrap lumber/old creosote telephone poles, several empty unlabeled 55-gallon drums, and rolls of wire.

Site 3 was investigated during several phases from 1990 to 2002, including the Phase I RI (Atlantic, 1992), FFS (Atlantic, 1994b), Phase II RI (B&RE, 1997), BGOURI (TtNUS, 2002a), and Data Gap

Investigation (DGI) for the BGOURI Update/FS (TtNUS, 2004). During completion of the Phase II RI, the Navy and regulators decided that the best strategy was to address the source area OUs at the site first and then address the groundwater OU. Groundwater at Site 3 was further investigated during the BGOURI in 2000, but the results of the investigation were inconclusive and data gaps remained.

During the RA for OU3, Site 3 - NSA was discovered adjacent to Stream 5 at Site 3. Sediment that exhibited potential petroleum contamination (i.e., odor and sheen on pooled water) was encountered during excavation activities along the northern side of Stream 5. Upon further investigation, rusted drums and steel cable intermingled with boulders and soil were evident in a small disposal area upgradient (north) of Stream 5 (see Figure 2-4). A sample of the contaminated sediment was collected and analyzed. Elevated levels of total petroleum hydrocarbons (TPH) were detected in the sample, indicating the presence of petroleum contamination. The NSA was not remediated at the time of the OU3 RA; however, absorbent booms and hay bales were put in place during construction activities to minimize migration of the contamination downstream, and plastic sheeting was placed along the stream bank prior to backfilling to minimize further contaminant migration to Stream 5.

To address the newly found Site 3 - NSA and the data gaps identified during the BGOURI, a DGI (TtNUS, 2002b) was completed in the fall of 2002 prior to initiating an FS. The results of the DGI were presented and evaluated in the BGOURI Update/FS (TtNUS, 2004), and remedial alternatives were developed to address the petroleum-contaminated soil associated with Site 3 - NSA. A ROD (Navy, 2004d) was signed for the site in October 2004. The ROD called for NFA under the CERCLA Program for the petroleum-contaminated soil because petroleum is excluded from consideration under CERCLA; however, the Navy's cleanup plan to address the petroleum-contaminated soil under other applicable regulations was detailed in an appendix of the ROD. The Site 3 – NSA soil corrective action was completed to meet Connecticut regulations in October 2007.

2.2.1.3 Site 7

Site 7, Torpedo Shops, is located in the northern portion of NSB-NLON on the northern side of Triton Road (Figure 2-2). The Navy conducts maintenance activities on torpedoes at the site. OU8 is the soil OU associated with Site 7. The major sources of contamination at Site 7 included potential historic disposal of solvents/chemicals into two on-site septic systems and leaks or spills associated with on-site underground storage tanks (USTs). Contaminated soil was found on the southern side of Building 325 and appeared to be related to former USTs used to store fuel oil. Groundwater and suspected soil contamination on the western side of the building appeared to be related to the septic tank, sewer lines, or leach field associated with the former septic system. The USTs were closed in the 1990s, and the septic systems were abandoned when sanitary sewers were installed in 1983.

Building 325 (Figure 2-5) is a torpedo overhaul facility, and it was built in 1955 and had an on-site septic system until 1983, when all of the building's plumbing facilities were connected to sanitary sewers. The original septic leach field for Building 325 is located southwest of the building, adjacent to Triton Road. This leach field became clogged in 1975 and was abandoned. A new leach field (south leach field) was constructed next to the original leach field and was used until sanitary sewers were installed in 1983.

Two underground No. 2 fuel oil tanks were located on the southern side of Building 325. One of the tanks was closed in 1995. A third tank, which was located above ground adjacent to the building, was used for temporary storage of No. 2 fuel oil but, based on field reconnaissance, had been removed as of March 15, 1995.

Building 450 (Figure 2-5) is the primary MK-48 torpedo overhaul/assembly facility. It was built in 1974 and was served by its own septic system until 1983, when it was connected to sanitary sewers. Only domestic wastewater from toilets, lavatories, and showers in Building 450 had been directed to the septic field (north leach field).

Site 7 was investigated during the Phase I RI (Atlantic, 1992), Phase II RI (B&RE, 1997), and BGOURI (TtNUS, 2002a). The combined soil and groundwater data sets from the three investigations were evaluated during the BGOURI. No additional investigations were conducted at the site during the DGI for the BGOURI Update/FS (TtNUS, 2004).

A ROD (Navy, 2004b) was signed for the soil at the site (OU8) in September 2004 which called for the excavation and off-site disposal of contaminated soil. This remedy was selected because there were potentially significant risks associated with exposure to the contaminated soil. The Site 7 soil remedial action was completed in 2006.

2.2.1.4 Site 14

Site 14, OBDANE, where miscellaneous wastes were dumped in the past, was located adjacent to Sites 3 and 7 in a wooded area on the edge of a ravine just north of Stream 3 (Figure 2-4). Site 14 was investigated during the Phase I RI (Atlantic, 1992), Phase II RI (B&RE, 1997), and BGOURI (TtNUS, 2002a). A Non-Time-Critical Removal Action (NTCRA) was completed at the site in 2001 to address the contaminated soil and debris identified at the site during the Phase II RI. A ROD (Navy, 2004b) was signed for the soil at the site (OU8) in September 2004 which called for NFA. This remedy was selected because the NTCRA addressed all significant risks associated with the soil and debris.

Because Site 14 was located adjacent to Site 3 and groundwater from Site 14 flows toward Site 3, it was decided to evaluate the groundwater OU beneath both sites jointly and this approach was taken in the

BGOURI. Subsequently, it was decided that groundwater at Sites 3 and 14 should be evaluated separately because of the different remedial strategies that might be applicable to the different sites. This approach was used in the BGOURI Update/FS (TtNUS, 2004). No additional sampling was conducted at Site 14 during the DGI for the BGOURI Update/FS because no significant contamination was discovered in the groundwater during the BGOURI.

2.2.1.5 Site 15

Site 15, Spent Acid Storage and Disposal Area, was used before and after World War II for the temporary storage of waste battery acid in a rubber-lined underground tank. The tank was reportedly 12 feet long by 4 feet wide by 4 feet high. The batteries were placed on a concrete pad next to the tank onto which some acids occasionally leaked. No major spills were ever recorded. A 1951 aerial photograph shows that the area around the tank was not paved. Acid from the batteries was stored in the tank and was subsequently pumped into a tank truck and disposed in the Area A Landfill (Site 2). The tank was filled in place with soil and capped with bituminous pavement.

Historical investigations completed at Site 15 include the Phase I RI (Atlantic, 1992), FFS (Atlantic, 1994a), Phase II RI (B&RE, 1997), Supplemental Sampling Event (CTDEP, 1997), and BGOURI (TtNUS, 2002a). An NFA Decision Document for Soil at Site 15 was submitted in September 2007. Groundwater and soil data collected at Site 15 during the DGI was included and evaluated in the BGOURI Update/ FS Report (TtNUS, 2004). Soil results from this investigation confirmed that the NFA Decision Document was appropriate and not need to be amended.

2.2.1.6 Site 18

The solvent storage area at Building 33 was identified during the IAS (Envirodyne, 1983) for NSB-NLON. The site was identified as Study Area F in the FFA and is now identified as Site 18, Solvent Storage Area, Building 33, in the IR Program. Site 18 was used for the storage of gas cylinders and 55-gallon drums of solvents such as TCE and dichloroethene. The site was not identified as a high priority site and as a result, no investigation of Site 18 was conducted during the early phases of investigation at NSB-NLON (e.g., Phase I or Phase II RIs). The Navy investigated the site during the BGOURI in 2000 to determine the impact of the operation of the storage facility. Both soil and groundwater samples were collected to characterize the site. The results of the investigation were documented in the BGOURI Report (TtNUS, 2002a). A ROD (Navy, 2004c) was subsequently signed for the soil at Site 18 (OU11) in September 2004. The Selected Remedy documented in the ROD was NFA because no significant risks associated with exposure to site soil were identified during the RI.

2.2.1.7 Site 20

Site 20, Area A Weapons Center, consists of Building 524, which is used for administration, minor torpedo assembly, and storage of simulator torpedoes, and the weapons storage bunkers (see Figure 2-9). Small quantities of chemicals (cleaning and lubricating compounds, paints, and adhesives) and chemical waste generated by on-site activities are stored at the site. Liquid fuels present in the weapons storage bunkers include Otto fuel, JP-10, and TH Dimer (jet rocket fuel).

Site 20 was indirectly investigated during the Phase I RI (Atlantic, 1992) as part of the investigation of Site 2B. The site was further investigated during the Phase II RI (B&RE, 1997), BGOURI (TtNUS, 2002a), and DGI for the BGOURI Update/FS (TtNUS, 2004). The DGI (TtNUS, 2002b), which included collection and analysis of additional groundwater samples, was conducted at the site in the fall of 2002 to address data gaps identified during the BGOURI. A ROD (Navy, 2000) for the site soil and sediment (OU7) was signed and called for excavation and off-site disposal of the contaminated soil and sediment. The remedial action was completed in 2001 and consisted of excavation and off-site disposal of less than 200 cubic yards of PAH- and arsenic-contaminated soil and sediment.

2.2.1.8 Site 23

Site 23, Tank Farm, comprises various former and current tanks and associated facilities including nine former USTs, a 30,000-gallon, double-walled UST (OT-10), 10,000-gallon waste oil tank, fuel oil loading area, tanker truck dumping pad and trough, two 150,000-gallon diesel ASTs, and other buildings. Five of the nine former tanks at Site 23 (OT-1, OT-2, OT-3, OT-4, and OT-6) had perimeter underdrains installed around them during their construction to depress groundwater levels. In addition, the storm sewers that the underdrains tie into were constructed of perforated corrugated metal pipe to help dewater the area. The underdrain at OT-6 was subsequently abandoned by the Navy around 1966 during completion of improvements to the storm sewer system. The soil at Site 23 was remediated in 1997 and 2000 under the CTDEP Resource Conservation and Recovery Act (RCRA) UST Program.

The Site 23 USTs were properly closed in place; however, the tank underdrain systems were allowed to remain in place to help reduce groundwater levels in the area. Evidence of releases of petroleum products from the tanks, their associated piping, and possibly from other nearby sources was detected in soil during previous investigations. No significant groundwater contamination was detected; however, petroleum hydrocarbons were detected periodically at the outfall of the storm sewer system near Goss Cove. The stormwater drainage system was rehabilitated in 2000 such that the original combined groundwater and stormwater system was separated into a deep groundwater and a new shallow stormwater system. The groundwater underdrain system continues to collect groundwater from the old tank drains. In 2000, new storm drain was installed using solid wall HDPE piping and much of the underdrain was relined with perforated plastic pipe. An existing manhole was modified to become a groundwater flow-metering and sampling pit. Beyond the metering pit, the groundwater underdrain pipe and stormwater collection pipes are recombined such that groundwater then enters the storm sewer system.

The objectives of the BGOURI at Site 23 were to further characterize the nature and extent of groundwater contamination and to quantify the risks to human receptors from the groundwater. Groundwater sampling results for Site 23 indicated that the water quality is generally good, with only sporadic, low-concentration detections of VOCs, SVOCs, and metals in site monitoring wells. A preliminary evaluation of natural attenuation data indicated that biodegradation and other natural attenuation processes might be acting to reduce organic contaminants to relatively insignificant levels in the Tank Farm. However, it was not recommended that a monitored natural attenuation alternative be pursued for the site. The BGOURI recommended that the decision for preparation of an FS for the groundwater OU at the Tank Farm be postponed until site conditions stabilize and the results of the sampling and analysis program for the groundwater collection system determined the trends in groundwater contaminant concentrations.

The Site 23 underdrain metering pit was sampled after construction and quarterly for a period of 1 year starting in June 2007. Samples were collected from the metering pit that collects groundwater from the Site 23 area underdrains from four former tanks. All relevant concentrations were less than established Connecticut criteria (with the exception of anomalous results as discussed in Section 2.5.2.7). Based on these results, Site 23 groundwater (including Site 9 groundwater) being collected and conveyed in the storm sewer system does not pose a significant threat to human health or the environment under the current land use scenario; however, risks would be unacceptable if groundwater at the site was used as a drinking water supply.

2.2.2 Enforcement Activities

On August 30, 1990, NSB-NLON was placed on the National Priorities List (NPL) by the EPA pursuant to CERCLA of 1980 and SARA of 1986. The NPL is a list of uncontrolled or abandoned hazardous waste sites identified by EPA as requiring priority RAs. The Navy, EPA, and the State of Connecticut signed the FFA for NSB-NLON in 1995 (EPA, 1995). The agreement is used to ensure that environmental impacts associated with past and present activities at NSB-NLON are thoroughly investigated and that the appropriate RA is pursued to protect human health and the environment. In addition, the FFA establishes a procedural framework and timetable for developing, implementing, and monitoring appropriate responses at NSB-NLON, in accordance with CERCLA (and SARA amendment of 1986, Public Law 99-499), 42 U.S.C. §9620(e)(1); the National Oil and Hazardous Substance Pollution Contingency Plan (NCP), 40 CFR 300; Resource Conservation and Recovery Act (RCRA), 42 U.S.C. §6901 et seq., as amended by the Hazardous and Solid Waste Amendment (HSWA) of 1984, Executive Order 12580; and applicable state laws. There have been no cited violations under federal or state environmental law or any past or pending enforcement actions pertaining to the cleanup of OU9.

2.3 COMMUNITY PARTICIPATION

The Navy has been conducting community relations activities for the IR Program at NSB-NLON since it began. From 1988 to November 1994, Technical Review Committee meetings were held on a regular basis. In 1994, a Restoration Advisory Board (RAB) was established to increase public participation in the IR Program process. Many community relations activities for NSB-NLON involve the RAB, which historically met quarterly and recently has met annually. The RAB provides a forum for discussion and exchange of information on environmental restoration activities between the Navy, regulatory agencies, and the community, and it provides an opportunity for individual community members to review the progress and participate in the decision-making process for various IR Program sites, including Sites 2A, 2B, 3, 7, 9, 14, 15, 18, 20, and 23.

The following community relations activities are conducted at NSB-NLON as part of the Community Relations Plan:

Information Repositories: The Public Libraries in Groton and Ledyard are the designated information repositories for the NSB-NLON IR Program. All pertinent reports, fact sheets, and other documents are available at these repositories.

Key Contact Persons: The Navy has designated information contacts related to the NSB-NLON. Materials distributed to the public, including any fact sheets and press releases, will indicate these contacts. The Public Affairs Officer will maintain the site mailing list to ensure that all interested individuals receive pertinent information on the cleanup.

Mailing List: To ensure that information materials reach the individuals who are interested in or affected by the cleanup activities at the NSB-NLON, the Navy maintains and regularly updates the site mailing list.

Regular Contact with Local Officials: The Navy arranges regular meetings to discuss the status of the IR Program with the RAB.

Press Releases and Public Notices: The Navy issues press releases as needed to local media sources to announce public meetings and comment periods, the availability of reports, and to provide general information updates.

Public Meetings: The Navy conducts informal public meetings to keep residents and town officials informed about cleanup activities at NSB-NLON, and at significant milestones in the IR Program. Meetings are conducted to explain the findings of the RI; to explain the findings of the FS; and to present the Proposed Plan, which explains the preferred alternatives for cleaning up individual sites.

Fact Sheets and Information Updates: The Navy develops fact sheets to mail to public officials and other interested individuals and/or to use as handouts at the public meetings. Each fact sheet includes a schedule of upcoming meetings and other site activities. Fact sheets are used to explain certain actions or studies, to update readers on revised or new health risks, or to provide general information on the IR Program process.

Responsiveness Summary: The Responsiveness Summary for the Proposed Plan summarizes public concerns and issues raised during the public comment period and documents the Navy's formal responses. The Responsiveness Summary may also summarize community issues raised during the course of the FS.

Announcement of the ROD: The Navy announces the signing of the ROD through a notice in actions or studies, to update readers on revised or new health risks, or to a major local newspaper of general circulation and a press release sent to everyone on the mailing list. The Navy places the signed ROD in the information repositories before any RAs begin.

Public Comment Periods: Public comment periods allow the public an opportunity to submit oral and written comments on the proposed cleanup options. Citizens have at least 30 days to comment on the Navy's preferred alternatives for cleanup actions as indicated in the Proposed Plan.

Technical Assistance Grant: A Technical Assistance Grant (TAG) from the EPA can provide up to $50,000 to a community group to hire technical advisors to assist them in interpreting and commenting on site reports and proposed cleanup actions. Currently, no TAG funds have been awarded.

Site Tours: The Office of Public Affairs periodically conducts site tours for media representatives, local officials, and others.

A notice of availability of the Proposed Plan for Sites 2A, 2B, 3, 7, 9, 14, 15, 18, 20, and 23 groundwater (Navy, 2008) was published on June 14, 2008, in *The New London Day* newspaper. The Proposed Plan and other documents related to these sites are available to the public in the NSB-NLON Information Repositories located at the Groton Public Library in Groton, Connecticut, and the Bill Library in Ledyard, Connecticut. The notice also announced the start of the 30-day comment period that ended on July 14, 2008. A copy of the notice and the Proposed Plan are included in Appendix C of this ROD.

The Proposed Plan notice of availability invited the public to attend a public meeting at the Best Western Olympic Inn in Groton, Connecticut on June 26, 2008. The public meeting presented the proposed remedies and solicited oral and written comments. At the public meeting, personnel from the Navy, EPA, and the CTDEP answered questions from the attendees during the informal portion of the meeting. In addition, public comments on the Proposed Plan were formally received and transcribed. The transcript for the public meeting is provided in Appendix D. Responses to the comments received during the public comment period are provided in the Responsiveness Summary in Section 3.0.

2.4 SCOPE AND ROLE OF OPERABLE UNIT

Sites 2A, 2B, 3, 7, 9, 14, 15, 18, 20, and 23 are 10 of the 23 IR Program sites within the 12 OUs currently included in the NSB-NLON IR Program. The overall goal of the IR Program at NSB-NLON is to cleanup sites to achieve compliance with State of Connecticut Remediation Standard Regulations (RSRs) and other ARARs. As with many Superfund sites, the problems at these sites are complex. As a result, the media at Sites 2A, 2B, 3, 7, 9, 14, 15, 18, 20, and 23 have been divided into separate OUs as follows:

- OU1 - Site 2A, Area A Landfill soil and groundwater.
- OU3 - Site 3 soil and sediment.
- OU6 - Site 15 soil.
- OU7 - Site 20 soil and sediment.
- OU8 - Sites 7 and 14 soil.
- OU9 - All groundwater in the Upper Subase of NSB-NLON including Sites 2A, 2B, 3, 7, 9, 14, 15, 18, 20, and 23.
- OU11 - Sites 16 and 18 soil.
- OU12 - Site 2B, Area A Wetland, sediment.

Interim remedies were selected for Sites 3, 7, 14, 15, 18, and 20 groundwater in the Interim ROD (Navy, 2004e). This Final ROD documents the selection of final remedies for all portions of OU9. The remedies selected for Site 2 soil and groundwater, Site 3 - NSA soil, Sites 7 and 14 soil, and Site 18 soil were documented in separate RODs (Navy, 1995, 2004b, 2004c, and 2004d). Site 15 soil (OU 6) was previously addressed by the Navy in a NFA Source Control ROD in 1997 (Navy, 1997b).

The Selected Remedies for groundwater at Sites 3 and 7 and Sites 9 and 23 will prevent potential future unacceptable risks to human health and the environment associated with contaminants in groundwater at these sites. The results of the risk assessments indicated no unacceptable risks to current receptors from exposure to groundwater at Sites 3 and 7 and Sites 9 and 23, but exposure to maximum concentrations of contaminants in groundwater at the sites could result in unacceptable risks to hypothetical future human receptors if they regularly consume the groundwater. In addition, based on the results of a 2008 vapor intrusion evaluation, vinyl chloride concentrations in groundwater at one well at Site 3 present unacceptable risks to humans if a building was built for residential purposes in the vicinity of this well.

Evaluation of the available analytical data indicated that no unacceptable health effects are anticipated from exposure to the groundwater at Sites 2A, 2B, 14, 15, 18, and 20. An NFA remedy was selected for the groundwater at Sites 14, 15, 18, and 20. Groundwater monitoring and institutional controls will continue at Sites 2A and 2B as part of the OU1 remedy.

2.5 SITE CHARACTERISTICS

2.5.1 Physical Setting

2.5.1.1 Site 2A – Area A Landfill and Site 2B – Area A Wetland

Sites 2A and 2B are located within a northwest-trending valley (northern valley) situated between the topographic/bedrock high that occupies the central area of the NSB-NLON and the topographic/bedrock high that forms the northern border of the NSB-NLON. Figure 2-4 shows the topography and surface features of these sites. The northern valley is relatively narrow in the eastern portion of the site near the earthen dike, but it widens to the west. Runoff from Site 2A drains as overland flow north into the Area A Wetland (Site 2B), which discharges to Area A Downstream Watercourses, Site 3.

Site 2A

Site 2A, located in the eastern portion of the northwest-trending valley, contains 10 to 20 feet of miscellaneous fill that consists of fine- to coarse-grained sand and gravel and ash, wood and brick fragments, paper, and asphalt. The fill is generally underlain by 10 to 20 feet of dredge spoils, mainly beneath the easternmost portion of the landfill. Where no spoils underlie the fill material, the fill directly overlies a thin alluvial layer or the bedrock surface. Along the southeastern border of the landfill, fill material is underlain by an alluvial layer consisting of silty sand. The alluvial layer is underlain by gravel and gneiss boulders. Bedrock beneath Site 2 has been identified as the biotite-quartz-feldspar gneiss of the Mamacoke Formation. The bedrock surface slopes to the northeast toward Site 2B from the large bedrock high in the center of the facility. In the western portion of the site, the landfill is situated immediately adjacent to a bedrock ridge, and depth to bedrock is typically less than 20 feet. The eastern portion of the landfill is located further from the hillside, and depth to bedrock increases to 70 feet in this area.

Groundwater is present within the dredge spoils, alluvium, and bedrock underlying the Area A Landfill. Depth to groundwater averages approximately 10 feet across the landfill, and in some areas, the lower portion of the fill materials is below the water table. The saturated thickness of the overburden materials ranges from less than 10 feet to at least 65 feet across the landfill. Overburden and bedrock groundwater flow northeast across most of Site 2A, from the topographic/bedrock high to Site 2B, the Area A Wetland. Upward groundwater gradients from bedrock to the overburden/fill are predominant, although a downward gradient exists at the 2LMW18 well cluster, located in the central portion of the landfill. Hydraulic potentials between bedrock and overburden groundwater differ by 3 to 7 feet, suggesting that although groundwater flow directions are similar, the degree of hydraulic connection varies spatially, and there is no restriction of flow between the overburden and bedrock in some areas. East of Site 2A, local groundwater flow is to the north and west into Site 2B. In this area, groundwater elevations in bedrock and the overburden are similar, and vertical gradients are minimal. In the western portion of the landfill near the dike, groundwater flows northwest toward Site 3.

The geometric mean hydraulic conductivity for the overburden, based on Phase II RI pumping test data, is 2.7 feet per day. This value corresponds to overburden hydraulic conductivities estimated based on slug tests conducted during the Phase II RI. Based on a hydraulic gradient of 0.033 across the landfill (from 1993 water level measurements), hydraulic conductivity of 2.7 feet per day, and an assumed effective porosity of 30 percent, the average seepage velocity is estimated at 0.3 foot per day. Figures 2-10 and 2-11 show regional groundwater flow patterns across Sites 2, 3, and 14 in the shallow overburden and bedrock, respectively, based on the August 2000 round of water-level measurements taken during the BGOURI.

Site 2B

Site 2B is underlain by dredge spoils that consist of silt and clay with traces of fine sand and shell fragments. The dredge spoils extend across the site southeast to 2WMW3 and southwest beneath the Area A Landfill. The thicknesses of dredge spoils are 25 to 35 feet on the southern side of the wetland and 10 to 15 feet on the northeastern side of the wetland. Where dredge spoils do not directly overlie bedrock, they are underlain by a thin remnant of topsoil consisting of organic-rich silt, clay, and traces of roots and underlain by alluvial deposits. The alluvial deposits consist primarily of sand with silt and/or gravel and are significantly coarser grained than the overlying dredge spoils. The thickness of the alluvium in Site 2B borings ranged from 0 to 36 feet. Bedrock beneath the southern portion of the wetland has been identified as the Mamacoke Formation; the northernmost portion of the wetland is underlain by the Granite Gneiss, a gneissic biotite granite. The bedrock surface slopes to the valley occupied by the wetland from northern, eastern, and central bedrock highs toward the center of the wetland.

Groundwater is present within the overburden and bedrock underlying the Area A Wetland, and the water table is close to the ground surface throughout most of the area. The dredge spoils and alluvium making up the overburden exist largely under saturated conditions. Groundwater flow in the overburden is from the northeast and southwest into the wetland and then west toward Site 3 (see Figures 2-10 and 2-11). Groundwater flow in the bedrock mimics the shallow overburden pattern and flows from higher elevations toward the bedrock valley and ultimately to site 3 through a combination of discharge to local streams and aquifer underflow. Groundwater elevations are similar in the overburden and bedrock, but the vertical gradient varies from upward to downward. Based on 1994 water level measurements, the hydraulic gradient in dredge spoils at the site is 0.00255, and hydraulic conductivity is 1.0 foot per day based on slug testing during the Phase I RI. Assuming an effective porosity of 0.30, the estimated groundwater seepage velocity through the dredge spoils is 0.008 foot per day. For the alluvium, a hydraulic conductivity of 6.8 feet per day was calculated based on Phase I RI slug testing. Using the same gradient and porosity, a flow velocity of 0.063 foot per day was calculated for the alluvium.

2.5.1.2 Site 3 – Area A Downstream Watercourses and OBDA and Site 14 – OBDANE

Sites 3 and 14 are located in the same northern valley as Sites 2A and 2B. Site 3 receives surface water and groundwater recharge from Sites 2A, 2B, 7, and 14, and surrounding areas. The streams within Site 3 convey the water to the Thames River. Site 14 is located adjacent to Stream 3.

The geology of Sites 3 and 14 consists of overburden deposits overlying metamorphic bedrock. The overburden consists of silty sand and gravel and is mapped as stratified drift of former meltwater streams [United States Geological Survey (USGS, 1960)]. Although these are natural materials, they have most likely been reworked in the area of the golf course. In general, the overburden thickness increases from the valley margins to the center of the valley and from southeast to northwest along the valley axis. The overburden thickness is less than 5 feet at well 2DMW10D and less than 15 feet at wells 2DMW25D and 2DMW27D. The overburden is thicker in the golf course area, and bedrock was not encountered in the 50-foot boring at well 2DMW26D. Well locations are shown on Figure 2-4.

The surface of the bedrock at Sites 3 and 14, identified as the Mamacoke Formation, slopes from the northern and central bedrock highs that surround the area toward the northwest-trending valley. There appears to be a localized bedrock high at well 2DMW15D. The depth to bedrock is only 4 feet at this location, and the bedrock surface elevation is higher than was encountered in surrounding boreholes. This local bedrock high corresponds to a local topographic high within the valley. The boring logs for monitoring wells installed near OBDA indicate that the overburden locally consists of sand and boulders. The depth to bedrock at Site 3 was approximately 15 feet. There are bedrock exposures upslope of Site 14, and bedrock was encountered at the site at depths of 12 feet below ground surface (bgs).

Groundwater is present in both the overburden and bedrock underlying Sites 3 and 14. The saturated thickness of the overburden ranges from a few feet along the valley margins to greater than 40 feet in the central portion of the stream valley. Depth to groundwater ranges from a few feet in the eastern portion to over 15 feet in the golf course area to the west. Figures 2-10 and 2-11 show regional groundwater flow patterns across Sites 3 and 14 in the shallow overburden and bedrock, respectively, based on the August 2000 round of water-level measurements taken during the BGOURI. Figures 2-12 and 2-13 show the local groundwater flow patterns in the shallow overburden and bedrock, respectively, based on October 2002 measurements. The figures show that groundwater flows from topographic/bedrock highs and Site 2B to Site 3. From the downstream area, groundwater flows west toward and discharges into the Thames River. Vertical gradients between the overburden and bedrock are mixed across Site 3 but are predominantly upward. A downward gradient was observed at well cluster 2DMW24S/D, and upward head differentials were observed at well clusters 2DMW16S/D, 2DMW25S/D, and 2DMW28S/D.

Along the valley margins and near the Site 2B dike, local groundwater flow gradients are steep. As the bedrock slope flattens and the overburden thickens, hydraulic gradients also flatten. The overall hydraulic gradient in the direction of groundwater flow across Site 3 within both the overburden and bedrock is approximately 0.024 based on the BGOURI 2000 water level data. In both the overburden and bedrock, the hydraulic gradient steepens slightly toward the Thames River.

Slug test results for Site 3 alluvium and bedrock wells, summarized in the BGOURI (TtNUS, 2002a), show that the average horizontal hydraulic conductivity of the alluvium is approximately 5.3 feet per day and that the average horizontal bulk hydraulic conductivity of the bedrock is approximately 1.8 feet per day. Using a flow gradient of 0.024, a hydraulic conductivity of 5.3 feet per day, and a measured porosity of 0.33, the average groundwater flow velocity through the predominantly sandy alluvial materials across Site 3 was calculated to be approximately 0.4 foot per day.

2.5.1.3 Site 7 – Torpedo Shops

Figure 2-4 shows the topography and surface features of Site 7. Site 7 is surrounded on the north and east by an exposed bedrock cliff. The cliff is the result of quarry activity along the northern bedrock high. The ground surface slopes gently to the southwest, and there is an earthen berm along the eastern boundary of the site. Surface water runoff from Site 7 flows southwestward to drainage swales and storm sewers located on the southern side of Buildings 325 and 450. Runoff contained by the berm and the storm sewer system drains through culverts under Triton Road into Site 3 (Stream 5) and eventually into the Thames River.

The geology of Site 7 consists of a southwestward-thickening wedge of overburden materials overlying metamorphic bedrock. Surficial deposits underlying Site 7 consist of fill material that varies in thickness from 2 to 10 feet and consists primarily of sand and gravel. The fill either lies directly on bedrock (in the northeastern portion of the site) or is underlain by up to 30 feet of silty sand (along the southwestern edge of the site). This area has a history of quarrying and filling, and the silty sand is natural alluvium. The bedrock in this area has been identified as the Mamcoke Formation. In the northeastern portion of the site, the bedrock surface is relatively flat and has a mild slope toward the southwest. The bedrock surface between groundwater monitoring wells 7MW1D and 7MW7S slopes at a grade of approximately 2 percent. The bedrock surface in this area has been altered by quarry activity. Overburden thickness is typically less than 6 feet in this area. Southwest of groundwater monitoring wells 7MW7S and 7MW2D and southeast of test boring 7TB10, the bedrock slopes to the west and southwest more steeply. The bedrock surface between groundwater monitoring wells 7MW7S and 7MW3D slopes at a steeper grade of approximately 14 percent. The overburden thickness increases to 30 to 40 feet in this area.

Groundwater was encountered in both the overburden and bedrock underlying Site 7. Depths to groundwater average less than 10 feet across the site. Within the overburden, the water table was generally encountered near the fill/alluvium interface at locations where both units were present. Figure 2-10 shows the overburden groundwater flow pattern across the Site 7 area based on August 2000 water level data. The figure shows that the general direction of shallow groundwater flow is to the west-southwest toward Site 3. Groundwater flow directions in the shallow bedrock, as determined during the BGOURI, are to the west and southwest (Figure 2-11). In the overburden, the hydraulic gradient across the site is approximately 0.02. Within the bedrock, the flow gradient appears to be slightly lower at 0.015.

Downward vertical gradients were consistently observed at Site 7. Groundwater monitoring well clusters 7MW2S/2D (alluvium/bedrock), 7MW3S/3D (combined fill and alluvium/deep alluvium), and 7MW5S/5D (combined overburden and bedrock/deeper bedrock) all had downward vertical gradients, indicating that the Site 7 area is a local recharge area for groundwater.

Slug tests were performed in three alluvium and two bedrock wells at Site 7 over the course of the various RI field investigations. The estimated site-specific average hydraulic conductivity for the alluvium, based on slug test results, is 11.4 feet per day. Using a hydraulic gradient of 0.02 and a measured porosity of 0.37, the estimated groundwater seepage velocity in the alluvium at the site is 0.62 foot per day.

2.5.1.4 Site 15 – Spent Acid Storage and Disposal Area

Figure 2-7 shows the surface features of Site 15. The entire area is covered with concrete or bituminous pavement. The site is located southwest of the central bedrock high, which narrowly extends to the south. The ground surface in the vicinity of the site and southwest is relatively flat. Surface water runoff from this site is collected by a storm sewer system that passes through the Tank Farm (Site 23) and Goss Cove Landfill (Site 8) sites and eventually discharges to the Thames River.

Geologic conditions at Site 15 consist of variable thicknesses of fill and natural alluvial deposits overlying metamorphic bedrock. The overburden at Site 15 consists primarily of silty sand alluvium. Boring logs indicate that in some intervals, there are traces of clay and in others, there are traces of gravel and rock fragments. Site 15 has been mapped as stratified drift deposited by glacial meltwater streams (USGS, 1960). Minor thicknesses of fill may be present overlying the silty sand in some areas of the site. The borings for wells 15MW1D and 15MW4S encountered silt layers of 26- and 24-foot thicknesses, respectively, beneath the silty sand interval. These deposits are also most likely stratified drift.

The bedrock surface slopes to the southwest across the site. Monitoring well 15MW1D was drilled to a depth of 46.5 feet bgs, where gneiss fragments of the Mamacoke Formation were encountered. Monitoring well 15MW4S was drilled to a total depth of 43 feet bgs. Bedrock was not positively identified in this boring; however, auger refusal was reached, suggesting that the bedrock surface may have been encountered. Northeast of the site along Rasher Avenue, bedrock crops out at ground surface.

During historical and recent investigations at this site, groundwater was encountered in the alluvium at depths of less than 10 feet bgs. Most overburden groundwater flow is expected to be through the silty sand layer, with the underlying silt deposit acting as a semi-confining unit. The groundwater generally flows to the south-southwest. There is a downward vertical gradient at the 15MW1 well cluster.

Water level measurements were taken in Site 15 monitoring wells during the BGOURI in 2000. The elevations were used in conjunction with water level data from other sites to create regional shallow overburden and bedrock potentiometric surface maps (see Figures 2-14 and 2-15, respectively). Water level measurements were also taken in Site 15 monitoring wells during a DGI in 2002. These data were used to prepare a site-specific potentiometric surface map for the shallow overburden groundwater at Site 15 (see Figure 2-16). Based on Figures 2-14 and 2-16, groundwater flow direction (southwest) in the shallow overburden groundwater was consistent during both rounds.

Based on information presented in the BGOURI Report (TtNUS, 2002a), the hydraulic gradient in shallow overburden across the site is approximately 0.024. During Phase II RI field work, slug tests were performed in wells 15MW1S and 15MW3S. The geometric mean of the calculated hydraulic conductivities is 0.76 feet per day. Assuming a porosity of 0.30, the estimated groundwater seepage velocity at Site 15 is 0.06 feet per day.

2.5.1.5 Site 18 – Solvent Storage Area, Building 33

Figure 2-8 shows the surface features of Site 18, located north of Site 15 and Site 23. A steep embankment exists on the northern and eastern sides of Building 33. The embankment slopes at an approximate gradient of 50 percent toward the south and west. The gradient flattens to approximately 5 percent on the southern and eastern sides of Building 33. Surface water runoff from this site is collected by a storm sewer system that passes through Site 23 and Site 8 and eventually discharges to the Thames River.

The SCS Soils Map (SCS, 1983) classifies the soil on the southern and western sides of Building 33 as Urban land. Upgradient of the site (north and east), bedrock exposures (Hollis-Charlton-Rock outcrop complex) are prevalent as the central bedrock high extends toward the south. The soils overlying the bedrock range from very stony fine sandy loam to gravelly loam.

Minimal subsurface investigation work has been performed at Site 18. The site has a veneer of silty sand overlying shallow metamorphic bedrock. The sand is fine to medium grained and contains trace to some gravel and rock fragments.

Groundwater levels were measured in temporary wells 18TW2 and 18TW4 on June 14, 2000. The elevations associated with these measurements are presented on Figure 2-8. The general direction of groundwater flow in the shallow overburden at Site 18 is to the south. Groundwater from this site eventually discharges to the Thames River. The saturated thickness of the overburden at the site varies from approximately 1 foot to greater than 5 feet.

2.5.1.6 Site 20 – Area A Weapons Center

Site 20 is located along the southern side of the northern topographic and bedrock high (see Figure 2-9). The ground surface generally slopes from the northern bedrock high across the site to the south toward the Site 2B. The ground surface across Site 20 was altered (flattened) when the bedrock was blasted during construction of Building 524. To the west and southwest, the ground surface slopes to a ravine (Site 3) and toward Site 14.

Two drainage culverts (one along the northwestern side and one along the southeastern side of the site) collect runoff from the surrounding hillsides and from Site 20 and discharge it to Site 2B. The drainage culvert along the northwestern side eventually discharges to a storm sewer that passes along the southern side of the site and discharges into Site 2B. The drainage culvert along the southeastern side collects runoff from the hillside north of the site and continues along the southeastern side of the site, eventually discharging to another area of Site 2B. Site 2B discharges to Site 3 and subsequently into the Thames River. Water typically flows in these drainage culverts immediately following precipitation events.

The overburden materials at Site 20 consist of 4 to 16 feet of coarse sand, gravel, and rock fill underlain by up to 17 feet of fine-grained dredge spoils. Test borings showed that 4 to 8 feet of fill material rests directly on bedrock (Mamacoke Formation) across Site 20. The overburden thickness generally increases to the south and east, toward the Site 2B.

The bedrock surface generally slopes to the southwest across the site, toward the valley occupied by Site 2. Bedrock elevations in the Site 20 area indicate that the bedrock surface does not slope uniformly and that localized bedrock surface depression(s) are present. The depressions are most likely the result of the blasting activities that occurred during the construction of Building 524.

Groundwater is present in both the overburden and bedrock underlying Site 20. The saturated thickness of the overburden deposits is variable, ranging up to 25 feet or more. Overburden groundwater is primarily found within the dredge spoil materials, and only the lowermost few feet of the coarser-grained fill deposits are saturated. Shallow overburden and bedrock groundwater contours for Site 20 and nearby areas, based on August 2000 water levels, are shown on Figures 2-10 and 2-11, respectively. Groundwater in both the overburden and bedrock at Site 20 flows to the west and southwest. Shallow overburden groundwater contours at Site 20 generated from water levels measured during the October 2002 DGI are shown on Figure 2-17. The site-specific contours and groundwater flow directions are generally similar to those measured in 2000.

The hydraulic gradient in the shallow overburden varies considerably across Site 20; it is steeper in the area of Building 524 and flatter at the storage bunkers near the Area A Wetlands. The overall groundwater flow gradient in the overburden, based on 2000 water level data, averages approximately 0.04. Assuming an average horizontal hydraulic conductivity in dredge spoil of 0.017 foot per day and in alluvium/fill of 2.0 feet per day (based on hydraulic testing completed at Site 2A) and a porosity of 0.30, the horizontal seepage velocity for overburden groundwater in this area ranges from approximately 0.0023 to 0.27 foot per day.

2.5.1.7 Site 9 – Waste OT-5 and Site 23 – Tank Farm

Site 23, within which Site 9 is located, is in the southern northwest-trending valley and is bordered on the north and south by bedrock highs. In this valley, the ground slopes mildly from approximately 50 feet above mean sea level in the eastern portion to near sea level along the Thames River. A former topographic depression at the former Crystal Lake between Tang Avenue and Crystal Lake Road was filled during construction of the Tank Farm. Figure 2-6 shows surface topography at the Tank Farm.

Due to the cover material and topography of the Tank Farm, a majority of the rain that falls on this site will infiltrate into the ground. Groundwater at this site is collected by a dewatering system. Surface runoff from some portions of the site is collected by a stormwater collection system. Both groundwater and surface water collected by the systems discharge to the Thames River at the Goss Cove Landfill.

The predominant overburden materials observed during the BGOURI at Site 23 were fill and reworked soil. The soils were generally silty, fine- to medium-textured sands with trace amounts of rock fragments. Below the fill deposits are natural alluvium consisting primarily of silty sand. The thickness of the alluvium is variable. In the western portion of the site, the alluvium extends to a depth of over 50 feet. The depth to bedrock encountered during the 1998 hydrogeologic investigation varied from 15 to 58 feet. The greatest depths to bedrock were encountered along the eastern and western site boundaries. The shallowest depths to bedrock were encountered in the central portion of the site, along its northern and southern boundaries.

Groundwater is present in both the overburden and bedrock underlying Site 23. Shallow overburden groundwater generally flows into the central area of Site 23 then west toward the Thames River. The flow pattern reflects the presence of the tank underdrain system and groundwater collection system in this area, both of which act as groundwater sinks (collection points). The shallow groundwater flow gradient varies widely across the site but averages about 0.01. Bedrock groundwater flow is generally to the west and southwest. The Tank Farm underdrains and groundwater collection system that have a significant influence on shallow groundwater flow patterns do not affect bedrock groundwater flow directions to any significant degree. The flow gradient in the bedrock averages about 0.014 across Site 23. Figures 4-14 and 4-15 show groundwater flow patterns in the shallow overburden across Site 23, based August 2000 of water-level measurements.

The average overburden hydraulic conductivities based on slug testing during the BGOURI was 2.3 feet per day. For bedrock wells, the hydraulic conductivities were 0.73 feet per day and 652 feet per day. The large range is typical of the difference between highly transmissive bedrock fractures and less transmissive fractures. Using an average gradient of 0.01, an average hydraulic conductivity of 2.3 feet per day, and an assumed porosity of 0.3, the average groundwater flow velocity in the overburden is approximately 0.8 foot per day.

2.5.2 <u>Nature and Extent of Contamination</u>

The Navy conducted various field investigations at Sites 2A, 2B, 3, 9, 7, 14, 15, 20, and 23 from 1990 to the present to assess the nature and extent of groundwater contamination. The investigations at Sites 2A, 2B, 3, 7, 20, and 23 focused on groundwater present in the overburden and bedrock, and the investigations at Sites 9, 14, 15, and 18 only focused on groundwater in the overburden. Sites 2A and 2B are located hydraulically upgradient of Site 3, Sites 14 and 20 are hydraulically upgradient of Sites 3 and 7, and Sites 15 and 18 are hydraulically upgradient of Sites 9 and 23.

Only one round of investigation was conducted at Site 18 to assess the nature and extent of contamination. The investigation focused on groundwater present in the overburden.

2.5.2.1 Sites 2A and 2B

Phase II RI

For Site 2A, the Phase II RI concluded that shallow groundwater contamination (i.e., VOCs, PCBs, and inorganics) exists at the site and recommended that institutional controls including groundwater monitoring and use restrictions be implemented. For Site 2B, the Phase II RI concluded that the site may pose a risk to construction workers due to potential exposure to manganese in groundwater and recommended that an FS be conducted to evaluate a limited action alternative that included groundwater monitoring and use restrictions.

BGOURI

Six VOCs were detected in groundwater samples collected during the BGOURI. Several of the VOCs were detected during previous soil and groundwater sampling events. Acetone was the only VOC COPC identified at Site 2. In general, acetone concentrations were less than 10 µg/L, with the exception of a concentration of 120 µg/L in well 2WMW39DS. Acetone is also known to be a common laboratory artifact.

Three SVOCs were detected in groundwater samples collected during the BGOURI. None of the detected concentrations exceeded any of the relevant screening criteria. One pesticide, 4,4’-DDD, was detected in a single groundwater sample. High dissolved solids were detected in the groundwater sample, and it is likely that the DDD was bound to the solids.

Fifteen metals were detected in unfiltered groundwater samples, and 13 metals were detected in filtered groundwater samples. Arsenic, barium, and mercury were the only metals identified as COPCs. Exceedances of background levels for these metals were sporadic; only one well (2WGW47DS) had concentrations of more than one metal in excess of background levels. Concentrations of the other detected metals were less than screening criteria. In general, metals concentrations were lower in the BGOURI than in previous investigations. This result was generally expected because only downgradient monitoring wells and not monitoring wells within the Area A Landfill were sampled during the BGOURI.

The BGOURI report recommended that the groundwater monitoring program being conducted in accordance with the OU1 ROD be continued to gather data to evaluate long-term trends in contaminant concentrations and that the decision about whether to proceed to an FS should be made after sufficient data were collected and evaluated.

Annual Groundwater Monitoring

Eight years of groundwater monitoring under the OU1 ROD have been completed. Year 7 (2006) results, the most recent available, indicate that copper was the only contaminant detected in groundwater at concentrations in excess of criteria, and the well in which it was detected was a reference well not a downgradient well. Based on the results of the monitoring program to date, the landfill cap is working properly and significant contaminant migration from the landfill to groundwater is not occurring. Also based on monitoring results, it was decided that an FS was not necessary for this site. Figure 2-18 presents the groundwater exceedance detected during Year 7 sampling.

2.5.2.2 Sites 3 and 14

Groundwater at Sites 3 and 14 was investigated independently and collectively throughout the various investigations. The nature and extent of contamination found during each investigation is discussed below.

Phase II RI

Site 3 - Overburden

Seven VOCs, including six halogenated aliphatics and benzene, were detected in groundwater samples collected from overburden wells at Site 3. Each VOC was detected in from 1 to 3 of 25 samples. Most of the VOCs were detected in well 2DMW29S, located along Triton Road in the north-central portion of the site. Maximum concentrations of total 1,2-dichloroethene [28 micrograms per liter (µg/L)], bromodichloromethane (2 µg/L), chloroform (12 µg/L), methylene chloride (11 µg/L), and vinyl chloride (VC) (130 µg/L) were detected in samples from this well. None of these chemicals were identified in the surface water samples collected from the adjacent drainageway (Stream 5) along Triton Road. The source(s) of this groundwater contamination is not known.

Two phthalate esters (plasticizers that are common field and laboratory contaminants) and benzoic acid were each detected in from one to three of the groundwater samples collected from overburden wells.

Twenty-three metals were detected in unfiltered groundwater samples collected from overburden wells, and 19 metals were detected in associated filtered groundwater samples. Greater than two-thirds of the maximum concentrations of metals were associated with samples collected from overburden wells 2DMW30S and 3MW12S. Notable results for metals included maximum concentrations of aluminum (97,400 µg/L), arsenic (23.9 µg/L), barium (835 µg/L), manganese (6,710 µg/L), vanadium (229 µg/L), and zinc (800 µg/L).

Site 3 - Bedrock

Five halogenated aliphatics (1,1,2,2-tetrachloroethane, total 1,2-dichloroethene, chloroform, methylene chloride, and TCE) were detected in groundwater samples collected from bedrock wells at Site 3. Each VOC was detected in from 1 to 4 of the 25 groundwater samples. TCE concentrations ranged from 1 µg/L to 17 µg/L. Maximum concentrations of 1,1,2,2-tetrachloroethane, total 1,2-dichloroethene, and TCE were detected during the Phase I RI in the groundwater sample collected from well 2DMW16D, located approximately 125 feet southeast of North Lake.

Eleven semivolatile organic compounds (SVOCs) were also detected in groundwater samples from Site 3 bedrock wells. Six PAHs, ranging in concentration from 1 to 4 µg/L, were detected in the groundwater sample from well 3MW12D collected during Round 1 of the Phase II RI. In addition, bis(2-ethylhexyl) phthalate was detected in five groundwater samples at concentrations ranging from 2 to 20 µg/L. Two additional phthalates, benzoic acid, and phenol were each detected in one or two groundwater samples at concentrations ranging from 0.5 to 5 µg/L. As previously noted, phthalates are considered to be common laboratory contaminants.

Twenty-two metals were detected in unfiltered groundwater samples from bedrock wells, and 18 metals were detected in associated filtered groundwater samples. Approximately 42 percent of the maximum concentrations of metals were associated with samples from bedrock well 3MW12D.

Site 14 - Overburden

One VOC (carbon disulfide) and one SVOC [bis(2-ethylhexyl) phthalate] were detected in the two groundwater samples collected from well 14MW1S. Both chemicals were detected at an estimated concentration of 1 µg/L. The results indicate that Site 14 is not a significant source of organic groundwater contamination.

Eleven metals were detected in unfiltered Site 14 groundwater samples, and 12 metals were detected in associated filtered groundwater samples. With the exception of aluminum (at 171 µg/L in unfiltered sample 14GW1S only), filtered and unfiltered results were at the same order of magnitude. Maximum concentrations of arsenic in filtered samples and of boron and cobalt in unfiltered samples exceeded respective concentrations of these metals detected in unfiltered groundwater samples from off-site residential wells.

BGOURI

Sites 3 and 14 - Overburden

Four VOCs (chloroform, cis-1,2-dichloroethene, TCE, and VC) were detected in one or more of the 10 groundwater samples collected from the overburden aquifer. Detected concentrations of these VOCs ranged from 1.71 µg/L (cis-1,2-dichloroethene) to 31.3 µg/L (VC) and were less than in samples collected during previous investigations. Acetone was detected at estimated concentrations of 27.8 and 28.9 µg/L in two samples collected from temporary wells installed in the overburden aquifer. VC (4.65 µg/L) and cis-1,2-dichloroethene (1.71 µg/L) were detected in one groundwater sample collected from a temporary well.

Several PAHs and 4-methylphenol were the only SVOCs detected in groundwater at Site 3. Concentrations of most of these SVOCs were low, ranging from 0.03 µg/L [benzo(k)fluoranthene] to 2 µg/L (4-methylphenol). With the exception of fluoranthene, which was detected in three groundwater samples, each SVOC was detected in only one groundwater sample. PAHs and 4-methylphenol were not detected in overburden groundwater samples collected during previous investigations.

Trace levels of 1,1-dichloro-2,2-bis(4-chlorophenyl)ethane (DDD) (0.019 µg/L) and 1,1,1-trichloro-2,2-bis(4-chlorophenyl)ethane (DDT) (0.034 µg/L) were detected in overburden well 2DMW30S. High levels of total suspended solids were measured in this well and are the likely cause of the detections of DDD and DDT in groundwater. Pesticides were not detected in overburden groundwater samples collected during previous investigations.

Fifteen metals were detected in unfiltered overburden groundwater samples, and nine metals were detected in filtered overburden groundwater samples. Concentrations of metals in filtered and unfiltered samples were relatively similar (i.e., at the same order of magnitude). In general, the detected concentrations of metals were low. Concentrations of all metals were lower in groundwater samples collected during the BGOURI than in samples collected during previous investigations.

Site 3 - Bedrock

Three VOCs (chloroform, cis-1,2-dichloroethene, and TCE) were detected in nine groundwater samples collected from the bedrock aquifer. TCE concentrations were low, ranging from 1.88 to 8.76 µg/L. In general, VOCs were detected infrequently in bedrock groundwater during the BGOURI. Chloroform, 1,2-dichloroethene (total), and TCE were also detected in bedrock groundwater samples collected during previous investigations. Concentrations of 1,2-dichloroethene and TCE detected during the BGOURI were less than concentrations detected during previous investigations. No SVOCs, pesticides, or PCBs were detected in groundwater samples collected from the bedrock aquifer.

Fourteen metals were detected in unfiltered bedrock groundwater samples, and eight metals were detected in filtered bedrock groundwater samples. Reported concentrations of metals in filtered and unfiltered samples were relatively similar (i.e., at the same order of magnitude). In general, the detected concentrations of metals were low. Concentrations of all metals were lower in groundwater samples collected during the BGOURI than in samples collected during previous investigations, with the exception of silver and zinc.

BGOURI Update/FS

Eight VOCs were detected in Site 3 groundwater samples collected during the DGI. Data collected during the DGI were used to evaluate the nature and extent of contamination associated with Site 3-NSA and to confirm the nature and extent of groundwater contamination detected during previous investigations. 1,1,2-Trichloroethane, carbon disulfide, toluene, and trans-1,2-dichloroethene were detected during the DGI but were not detected during the BGOURI. These VOCs were detected infrequently (less than 25 percent of the samples) and at relatively low concentrations (less than 2 µg/L). The compounds cis-1,2-dichloroethene, TCE , and VC were detected at lower concentrations (less than 3 µg/L) during the DGI than the BGOURI (less than 32 µg/L). All of these wells are located along Stream 5 in the northern portion of Site 3.

Chlorinated VOCs have been consistently detected in several Site 3 wells since the Phase II RI. It appears that VOC contamination (TCE) was originally released in the Site 7 area (leach fields) and migrated to Site 3.

Seven SVOCs, all PAHs, were infrequently detected in groundwater samples collected during the DGI. No PAHs were detected in the samples collected from permanent monitoring wells, and all of the maximum concentrations were less than 1 µg/L in one temporary well. The source of the detected PAHs may be the PAH-contaminated soil (i.e., suspended solids in the temporary well) or the petroleum hydrocarbon contamination associated with the NSA.

The only pesticides detected in groundwater were alpha- and beta-BHC, and they were detected only in the sample from one temporary well (same well as the PAH detections). These pesticides were detected at low concentrations in soil samples, but it is unlikely that they have leached at significant dissolved concentrations to groundwater. It is more likely that these groundwater detections were the result of suspended solids incorporated into the groundwater sample during sampling.

Thirteen inorganics were detected in unfiltered samples collected during the DGI, but only eight inorganics were detected in filtered samples. It is likely that elevated inorganics concentrations in unfiltered samples are related to suspended solids incorporated into groundwater samples from temporary wells. Overall, DGI results indicate that Site 3 - NSA is not a significant source of inorganic contamination at Site 3.

<u>Quarterly Groundwater Monitoring</u>

The first year of quarterly groundwater monitoring at Site 3 was conducted from May 2006 to April 2007 (TtNUS, 2007) in accordance with the Work Plan for Remedial Action at Sites 3 and 7 (TtNUS, 2006b) and Operation and Maintenance (O&M) Manual for IR Program Sites (TtNUS, 2006a). Site 3 COCs, as presented in the Remedial Action Work Plan, are TCE and VC. Groundwater samples were collected from nine wells at Site 3 during quarterly sampling. No COCs were detected in six of the nine wells sampled during Year 1 of the monitoring program. Year 1 exceedances of remedial goals (RGs) included TCE in 3MW16D during the first quarter and in 2DMW16D during all four quarters and VC in 2DMW29S during the second and fourth quarters. Wells 3MW16D and 2DMW29S are located near Stream 5 and are downgradient of the former Site 7 leach fields. The TCE concentration in 3MW16D during the first quarter was 5.1 µg/L, slightly greater than the RG of 5 µg/L. VC concentrations in 2DMW29S have decreased from a maximum of 130 µg/L in 1994 to 4 µg/L during the last sampling round (slightly greater than the RG of 1.6 µg/L). Well 2DMW16D is located on the southern side of Site 3 and is not downgradient of the former Site 7 leach fields. It appears that the Area A Landfill or an unknown upgradient area of contamination is the source of TCE in this well. TCE concentrations in 2DMW16D have decreased from a maximum of 17 µg/L in 1991 to a maximum of 7 µg/L during Year 1 monitoring. Based on the results of Year 1 monitoring, no changes to the Site 3 monitoring program were recommended in the Year 1 Annual Groundwater Monitoring Report. Tables 2-1 and 2-2 present Year 1 groundwater monitoring data from Sites 3 and 7, respectively, and Figure 2-19 presents exceedances detected during the first year of monitoring.

2.5.2.3 Site 7

<u>Historical Investigations - Combined Results of Phase I and II RIs</u>

Overburden

Eight VOCs, including six chlorinated aliphatics, 2-butanone, and carbon disulfide were detected in groundwater samples collected from Site 7 overburden wells. 1,1,1-Trichloroethane and

1,1-dichloroethane were each detected in 6 of 20 groundwater samples, at concentrations ranging from 2 µg/L to 42 µg/L. 1,1-Dichloroethene was detected in four groundwater samples at concentrations ranging from 1 µg/L to 2 µg/L. The remaining VOCs were detected in one or two samples at concentrations ranging from 1 µg/L to 10 µg/L. Maximum concentrations of all VOCs except 2-butanone, chlorobenzene (CB), and methylene chloride were associated with the sample collected from well 7MW3S, located west of Building 325 in the southern leach field.

Thirteen SVOCs, including six PAHs, three phthalates, 1,4-dichlorobenzene (1,4-DCB), benzoic acid, dibenzofuran, and phenol, were detected in the 20 groundwater samples collected from overburden wells at Site 7. Benzoic acid and di-n-butyl phthalate were detected in six and four samples, respectively. The remaining SVOCs were each detected in only 1 or 2 of 20 samples. With the exception of bis(2-ethylhexyl) phthalate, which was detected in a single groundwater sample at a concentration of 380 µg/L, all SVOC concentrations ranged from 0.5 µg/L to 9 µg/L. Maximum concentrations of eight SVOCs were associated with groundwater samples collected from well 7MW8S, located along Triton Road in the western portion of the site.

Twenty-two metals were detected in unfiltered groundwater samples collected from overburden wells, and 15 metals were detected in the corresponding filtered groundwater samples. In general, maximum concentrations of metals in unfiltered and filtered samples were within the same order of magnitude. Close to half of the maximum concentrations of metals were associated with groundwater samples collected from well 7MW3D, located near Triton Road and west of the southern leach field.

Analyses for oil and grease were performed on four of the groundwater samples. The sample from well 7MW3D had an oil and grease a concentration of 600 µg/L. TPH analyses were performed for nine of the groundwater samples collected from overburden wells. TPH was detected in two samples (both collected from well 7MW8S) at concentrations of 700 µg/L and 1,200 µg/L. This well is located along Triton Road, downgradient of Buildings 325, 450, and 477.

Bedrock

Minimal organic contamination was detected in groundwater samples collected from Site 7 bedrock wells. 1,1,1-Trichloroethane (2 µg/L), methylene chloride (1 µg/L), benzoic acid (0.7 µg/L), and phenol (0.8 µg/L) were detected in samples collected from well 7MW5D. 4-Methyl-2-pentanone, methylene chloride, and total xylenes were detected in one well each. No other VOCs, SVOCs, pesticides, or PCBs were detected.

Twenty-four metals were detected in unfiltered groundwater samples from bedrock wells, and 14 metals were detected in the corresponding filtered groundwater samples. Maximum concentrations of barium, copper, iron, lead, and zinc in unfiltered samples were more than five times greater than maximum concentrations of respective concentrations in filtered samples. This indicates that the concentrations in unfiltered samples may be caused by the presence of suspended sediments and may not actually represent contamination of the groundwater. More than half of the maximum concentrations of metals were associated with groundwater samples collected from well 7MW5D, located near the southwestern corner of Building 450. In addition, several maximum concentrations were associated with groundwater samples collected from well 7MW4S, located near the southeastern corner of Building 325.

<u>BGOURI</u>

Overburden – Temporary Wells

The VOCs 1,4-DCB, benzene, and CB were detected in overburden temporary monitoring wells. 1,4-DCB concentrations ranged from 1.83 to 90.5 µg/L, benzene was detected in one sample at 2 µg/L, and CB was detected at concentrations of 6.66 µg/L and 165 µg/L. Based on the locations of the wells (see Figure 2-5), it is likely that these detections are related to the septic tank located along the western side of Building 325. The septic system is no longer used, but the disposition of the tank is not known.

Three of the 10 temporary monitoring wells were analyzed for SVOCs. The only SVOC detected in temporary monitoring wells was bis(2-ethylhexyl) phthalate at concentrations of 44 and 49 µg/L.

Seventeen metals were detected in the groundwater samples collected from Site 7 temporary monitoring wells. Maximum detected concentrations were all detected in one well, and arsenic, barium, chromium, cobalt, copper, nickel, silver, vanadium, and zinc were detected only in this well. Calcium, magnesium, manganese, potassium, and sodium were detected in all three samples. Aluminum, iron, and lead were detected in two of three samples. Of these detected metals, aluminum, arsenic, barium, chromium, iron, lead, nickel, silver, vanadium, and zinc were detected at concentrations in excess of background concentrations. The total suspended solids content in sample S7TW0901 was two orders of magnitude higher than in the other two samples; this may account for the elevated metals concentrations in this sample.

Overburden – Permanent Monitoring Wells

The VOCs 1,3-DCB, 1,4-DCB, and TCE were detected in permanent overburden monitoring wells at Site 7. 1,3-DCB and 1,4-DCB were detected only in one well at 2 µg/L. TCE was detected in four wells at concentrations ranging from 1.93 to 23 µg/L. The SVOCs detected in permanent monitoring wells were bis(2-ethylhexyl) phthalate, fluorene, hexachlorobenzene (HCB), and phenanthrene. Phenanthrene and bis(2-ethylhexyl) phthalate were detected in one sample at concentrations of 6.5 and 190 µg/L, respectively. HCB was detected in one sample at 3 µg/L. Fluorene was detected in two samples at 0.26 and 6.5 µg/L, respectively.

Seventeen inorganics were detected in unfiltered groundwater samples from Site 7 permanent bedrock monitoring wells. Maximum detected concentrations were scattered among the 13 wells. Arsenic, cadmium, chromium, selenium, and vanadium were detected in only 1 of 13 samples. Aluminum, copper, iron, and lead were detected in 4 to 5 of 13 samples. Barium, cobalt, and zinc were detected in 8 of 13 samples. Manganese was detected in 11 of 13 samples. Calcium, magnesium, potassium, and sodium were detected in all 13 samples. Arsenic, cadmium, lead, selenium, and zinc were detected at concentrations in excess of background concentrations. Arsenic was detected at 2.9 µg/L, in excess of the risk-based COPC screening level (Region 9 PRG) but not in excess of the CTDEP surface water protection criterion (SWPC) (CTDEP, 1996). Zinc, detected at a maximum concentration of 194 µg/L, was the only analyte present at a concentration in excess of CTDEP pollutant mobility criteria.

Bedrock – Permanent Wells

TCE was the only VOC detected in Site 7 bedrock groundwater samples collected during the BGOURI. TCE was detected in three samples at concentrations ranging from 1.54 to 7.58 µg/L, all in excess of the risk-based COPC screening level (Region 9 PRG) but less than the CTDEP SWPC.

Eleven metals were detected in unfiltered bedrock groundwater samples, with the majority of maximum concentrations detected in two samples. Calcium, magnesium, potassium, and sodium were the only metals detected in all four bedrock groundwater samples. Copper and nickel were only detected in one sample. The remaining detected metals were detected in two to three of the four samples collected. The concentrations of lead, nickel, and zinc were in excess of background concentrations.

Quarterly Groundwater Monitoring

The first year of quarterly groundwater monitoring at Site 7 was conducted from May 2006 to April 2007 (TtNUS, 2007) in accordance with the Work Plan for Remedial Action at Sites 3 and 7 (TtNUS, 2006b) and O&M Manual for IR Program Sites (TtNUS, 2006a). Groundwater samples were collected from eight wells at Site 7 during quarterly sampling. Site 7 COCs, as presented in the Remedial Action Work Plan, are 1,4-DCB, benzene, CB, HCB, and TCE. No COCs were detected at concentrations greater than RGs during Year 1 monitoring. Based on the results of Year 1 monitoring, no changes to the Site 7 monitoring program were recommended in the Year 1 Annual Groundwater Monitoring Report. Tables 2-1 and 2-2 present Year 1 groundwater monitoring data from Sites 3 and 7, respectively, and Figure 2-19 presents exceedances detected during the first year of monitoring at Sites 3 and 7.

2.5.2.4 Site 15

Phase II RI

Ten groundwater samples were collected from five overburden wells at Site 15 during Rounds 1 and 2 of the Phase II RI in 1994. Carbon disulfide was detected at a concentration of 3 µg/L in one well during Round 1 of the Phase II RI. No other VOCs were detected. Five SVOCs [1,4-DCB, bis(2-ethylhexyl) phthalate, di-n-butyl phthalate, naphthalene, and phenanthrene] were detected in groundwater samples. The two phthalates, plasticizers that are common field and laboratory contaminants, were each detected in 4 of 10 samples. The remaining SVOCs were each detected in 1 or 2 of 10 samples. Concentrations of bis(2-ethylhexyl) phthalate ranged from 0.6 to 45 µg/L. Concentrations of the remaining SVOCs ranged from 0.5 to 1 µg/L. The pesticide heptachlor was also detected at a concentration of 0.54 µg/L.

Twenty-one metals were detected in unfiltered groundwater samples, and 17 metals were detected in corresponding filtered groundwater samples. A majority of the maximum concentrations were associated with samples collected from wells 15MW3S and 15MW2S, located downgradient and upgradient, respectively, of Site 15. Notable results reported for Site 15 groundwater samples include maximum concentrations of manganese in both filtered and unfiltered groundwater samples at 3,080 µg/L and maximum concentrations of zinc in filtered and unfiltered groundwater samples at 450 µg/L and 453 µg/L, respectively. The maximum lead concentration in one unfiltered groundwater sample from 15MW3S (21.2 µg/L) was significantly higher than subsequent filtered (2 µg/L) and unfiltered (4.4 µg/L) samples collected from the same well.

BGOURI

Four additional groundwater samples were collected at Site 15 during the BGOURI in 2000. TCE, the only VOC detected during the BGOURI, was not detected in groundwater at this site during previous sampling events. TCE was detected in three of four groundwater samples at concentrations ranging from 2.32 to 16 µg/L. The source of the TCE was unknown. Anthracene, fluoranthene, and pyrene were detected in one well at concentrations less than 100 µg/L. None of these SVOCs were detected in groundwater samples collected during the Phase II RI.

Fifteen inorganics were detected in groundwater samples collected from Site 15. Seven of the 15 metals were detected in all four samples. Cadmium, chromium, lead, nickel, and silver were detected at elevated concentrations. Lead was the only inorganic detected at significant levels during both the Phase II RI and BGOURI. Chromium and lead were detected in all four BGOURI samples.

Lead was detected at concentrations less than the risk-based COPC screening criterion in all samples except in 15MW1S01 (24.7 µg/L). Lead concentrations exceeded the background concentration in samples 15MW1S01 and 15MW2S01. The groundwater in 15MW2S was acidic (pH = 4.44), the groundwater in 15MW1S and 15MW3S was slightly acidic (pH = 5.75 and 5.91, respectively), and the groundwater in 15MW1D was near neutral (pH = 6.9). Lead was detected at 2.8 J µg/L in the deep overburden aquifer well 15MW1D. The pH data and the detected concentrations of lead indicate that residual contamination from the former SASDA is impacting the shallow overburden groundwater.

Silver was detected in 3 of 3 samples at concentrations ranging from 79.1 µg/L (15MW1D) to 615 µg/L (15MW2S). The maximum silver concentration was found in well 15MW2S, which also had the lowest pH (4.44). Concentrations of silver decrease in the downgradient direction, but the existing monitoring well network at Site 15 does not extend far enough downgradient to fully define the most downgradient extent of silver in groundwater. Even though the monitoring well network is limited at Site 15, silver was not detected in any downgradient groundwater samples at Site 23. Therefore, it does not appear that silver is migrating to downgradient locations at significant concentrations.

Of the 10 remaining detected metals, concentrations of aluminum, beryllium, and zinc were in excess of background concentrations.

<u>BGOURI Update/FS</u>

Additional groundwater samples were collected at Site 15 during a DGI in 2002 and analyzed to further define the nature and extent of contamination at the site. The sampling program focused on the groundwater contaminants, including TCE, chromium, and silver, identified during the BGOURI.

Groundwater samples were analyzed for TCL VOCs, TAL metals, and acidity. Table 2-3 summarizes the results for Site 15 groundwater samples collected for the BGOURI Update/FS.

Chloroform was the only VOC detected in the six groundwater samples. It was detected once in the sample from 15TW03 at a concentration of 3 µg/L. TCE, which was detected in groundwater samples from three monitoring wells (15MW1S, 15MW2S, and 15MW3S) during the BGOURI, was not detected in the groundwater samples collected from these wells or the three new temporary monitoring wells during the DGI. Considering both soil and groundwater data from Site 18 (and BGOURI groundwater data from other sites), it was determined that the detections of TCE in groundwater samples during the BGOURI were anomalies (apparently related to laboratory or field sampling issues) and are not indicative of a site or upgradient source issue.

Fifteen inorganics were detected in both total and filtered groundwater samples collected from Site 15 during the DGI. Zinc was detected at total and dissolved concentrations in excess of the background concentration. The dissolved concentrations of aluminum in two samples were also greater than the background level. The total and dissolved concentrations of inorganics were similar for the DGI samples, indicating that proper low-flow sampling techniques were used and that turbidity/total suspended solids (TSS) did not influence analytical results.

The inorganics cadmium, chromium, lead, nickel, silver, and zinc were identified as groundwater COPCs during the BGOURI. Cadmium was detected in only one sample (15TW02) during the DGI at a concentration (4.4 µg/L), similar to the maximum concentration (3.4 µg/L) detected during the BGOURI. Chromium, lead, and silver were detected at total concentrations that were one to three orders of magnitude lower during the DGI than the BGOURI. Nickel was not detected in any of the groundwater samples collected during the DGI. The maximum total zinc concentration during the DGI (365 µg/L) was detected in the same well (15MW2S) and at the same magnitude (349 µg/L) as during the BGOURI.

2.5.2.5 Site 18

An evaluation of the nature and extent of groundwater contamination at Site 18 is provided below. The discussion includes groundwater data collected during the BGOURI in 2000. Groundwater sample locations are shown on Figure 2-8, and Table 2-4 presents a summary of groundwater analytical results from the BGOURI.

No VOCs, SVOCs, pesticides, or PCBs were detected in the groundwater samples collected at Site 18.

Aluminum, beryllium, calcium, iron, magnesium, manganese, potassium, and sodium were detected in one or both of the groundwater samples collected at Site 18. The concentrations of these metals were all less than background levels except beryllium, which was not detected in background samples. The concentration of beryllium was les than the risk-based COPC screening level (Region 9 PRG) and CTDEP SWPC.

2.5.2.6 Site 20

<u>Phase II RI</u>

Overburden

No overburden groundwater samples were collected from Site 20 during the Phase I RI. Three overburden wells were installed and sampled during the Phase II RI; however, no VOCs were detected. Five SVOCs were detected at low concentrations. A common field and laboratory contaminant, bis(2-ethylhexyl)phthalate, was detected in three of six samples at concentrations ranging from 2 µg/L to 3 µg/L. 1,3-DCB (0.6 µg/L), benzo(g,h,i)perylene (1 µg/L), dibenzo(a,h)anthracene (0.8 µg/L), and indeno(1,2,3-cd)pyrene (1 µg/L) were each detected in one of two groundwater samples collected from well 2WCMW1S.

Nineteen metals were detected in unfiltered groundwater samples collected from the overburden wells. Sixteen metals were detected in the corresponding filtered groundwater samples. A majority of the maximum concentrations of metals were associated with groundwater samples collected from well 2WCMW3S, located south of the site along the drainageway into Site 2B. Concentrations of metals in filtered and unfiltered samples were relatively similar (i.e., at the same order of magnitude). Notable concentrations reported for groundwater samples include the maximum concentrations of arsenic (19.9 µg/L), boron (3,810 µg/L), manganese (6,540 µg/L), and sodium (3,580,000 µg/L).

Bedrock

Three groundwater samples were collected (during the Phase I RI and Rounds 1 and 2 of the Phase II RI) from a single Site 20 bedrock well (2WMW4D). Six VOCs, including three ketones and three halogenated aliphatics, were detected at concentrations ranging from 1 µg/L to 12 µg/L. Three SVOCs were detected at concentrations ranging from 2 µg/L to 7 µg/L. Benzoic acid and di-n-octyl phthalate were each detected in one of three samples, and bis(2-ethylhexyl)phthalate was detected in two of three samples.

Thirteen inorganics were detected in unfiltered groundwater samples collected from the bedrock. Seven inorganics were detected in the corresponding filtered groundwater samples. The maximum concentrations of a majority of inorganics in overburden well samples were more than an order of magnitude greater than respective maximum concentrations of inorganics detected in bedrock well samples.

<u>BGOURI</u>

Overburden

TCE and 4-methyl-2-pentanone were the only VOCs detected in the groundwater samples collected from the overburden wells at Site 20. TCE and 4-methyl-2-pentanone were detected in one sample from well 2WCMW2S at concentrations of 5.02 µg/L and 1.29 J µg/L, respectively. VOCs were not detected in groundwater samples collected from the overburden aquifer during previous investigations.

PAHs and 4-methylphenol were the only SVOCs detected in groundwater samples collected from the overburden aquifer. PAHs were detected in one groundwater sample from well 2WCMW2S at concentrations ranging from 0.03 µg/L [benzo(k)fluoranthene] to 0.13 µg/L (fluoranthene). 4-Methylphenol was detected in one sample from well 2WCMW3S at a concentration of 9 µg/L. PAHs were also detected at low concentrations in groundwater samples collected during previous investigations.

Sixteen metals were detected in unfiltered overburden groundwater samples, and two metals (calcium and zinc) were detected in filtered overburden groundwater samples. The concentrations of the metals were higher in unfiltered samples than in filtered samples. In general, metals were also detected at similar concentrations (i.e., at the same order of magnitude) in groundwater samples collected during the previous investigations.

Bedrock

TCE, at a concentration of 3.8 µg/L, was the only VOC detected in the groundwater sample collected from the bedrock aquifer. TCE was also detected at similar concentrations in groundwater samples from the bedrock aquifer during previous investigations.

No SVOCs were detected in the groundwater sample collected from the bedrock aquifer. Benzoic acid, bis(2-ethylhexyl) phthalate, and di-n-octyl phthalate were detected at low concentrations in groundwater from the bedrock aquifer during previous investigations.

Calcium, magnesium, potassium, and sodium were the only inorganics detected in the groundwater sample from the bedrock aquifer. These inorganics were also detected at similar concentrations (i.e., at the same order of magnitude) in groundwater samples collected from the bedrock aquifer during previous investigations.

BGOURI Update/FS

Monitoring wells 2WCMW1S and 2WCMW2S were resampled during the DGI and analyzed for total and dissolved TAL inorganics. Wells 2WCMW1S and 2WCMW2S were resampled because elevated concentrations of silver were detected during the BGOURI. Other groundwater COCs identified during the BGOURI risk assessment included TCE, benzo(a)pyrene, arsenic, and thallium. These COCs were further evaluated during the preparation of the DGI Work Plan. Factors such as the frequency and magnitude of the detections and the source of the contamination were evaluated, and it was determined that additional investigation of these four COCs was not warranted during the DGI.

Table 2-5 summarizes the analytical results for chemicals detected in groundwater at Site 20 during the DGI. The concentrations of inorganics detected during the DGI were typically lower than concentrations detected during the BGOURI. Concentrations of arsenic, chromium, copper, lead, silver, and zinc were significantly lower in well 2WCMW1S. The silver concentration in 2WCMW2S also decreased significantly. Some exceptions were aluminum and zinc, which were detected at higher concentrations in well 2WCMW2S during the DGI.

2.5.2.7 Sites 9 and 23

BGOURI

During BGOURI field activities in 2000, groundwater samples were collected from monitoring wells at Site 23 completed in the overburden and bedrock aquifers (TtNUS, 2002a). VOCs and SVOCs were detected infrequently in groundwater samples collected during the BGOURI. Metals were detected frequently in groundwater samples, but the detections are likely related to the fill material used to construct the fuel farm. The RI recommended postponing any decisions on the groundwater at Site 23 until a sufficient amount of data was available from the groundwater collection system monitoring program to properly characterize the groundwater.

Storm Sewer Rehabilitation

The storm sewer system at Site 23 was rehabilitated in 2000 (FWEC, 2001). After completion of the storm sewer system, groundwater collected from the deep dewatering system around the closed USTs is conveyed to a metering pit within the tank farm. The metering pit is connected to the shallow stormwater system, and the water collected by the system is conveyed to the Thames River. The Navy initiated a sampling program for the deep groundwater collection system after construction activities were completed.

Seven groundwater samples were collected from the metering pit between July 25, 2000 and May 23, 2001. The analytical results varied per round and no comparisons of data to Connecticut criteria were completed, but in general, the groundwater samples did not contain significant concentrations of contaminants typically found in fuel oil.

Quarterly Underdrain Metering Pit Sampling

Metering pit sampling was conducted quarterly beginning in June 2007 to evaluate the quality of groundwater being collected and conveyed by the underdrain piping (TtNUS, 2008c). Table 2-6 summarizes data from quarterly metering pit sampling. Exceedances of applicable Connecticut groundwater criteria (for surface water protection) included arsenic in the unfiltered sample during the second quarterly event (September 2007) and seven SVOCs in one sample during the third sampling event (December 2007). However, both of these exceedances were attributed to suspended solids particles and not site-related contamination. The results of the four quarterly sampling events indicate that groundwater from Site 23 (which includes Site 9) being collected and conveyed in the storm sewer system does not pose a significant risk to human health or the environment under current and expected future land use (non-residential).

2.5.2.8 Summary of Nature and Extent of Contamination

Site 2

Eight years of groundwater monitoring under the OU1 ROD have been completed. Year 7 (2006) results, the most recent available, indicate that copper was the only contaminant detected in groundwater at concentrations in excess of criteria. Based on the results of the monitoring program to date, the landfill cap is working properly and significant contaminant migration from the landfill to groundwater is not occurring.

Site 3

Chlorinated VOCs (e.g., cis-1,2-dichloroethene, TCE, and VC) and PAHs were the primary contaminants detected in the groundwater at Site 3. Chlorinated VOCs were detected during all of the investigations, and it is likely that their detections are the result of solvents being released to groundwater via the two former septic systems and associated leach fields at Site 7 and migrating downgradient to Site 3. The concentrations of the VOCs detected during the most recent investigation (2002) were less than concentrations detected during previous investigations (1994), indicating that a continuing source of contamination is not present and that natural degradation processes are working. The VOCs were found primarily along the length of Stream 5. The PAHs, which were detected infrequently, were found to be related to suspended solids in samples collected from recently installed and sampled temporary wells and not a site-specific groundwater concern.

Site 7

Investigations at Site 7 found contaminants such as benzene, chlorobenzenes (1,4-DCB, CB, and HCB), phenanthrene, and TCE in the groundwater. The contaminants were probably released to the groundwater via the two historical septic systems and associated leach fields.

Site 14

A single well was installed at Site 14 and sampled in 1994 and 2000. Naturally occurring metals were the only chemicals consistently detected in the groundwater at this site.

<u>Site 15</u>

Historical investigations at Site 15 identified TCE and inorganics (cadmium, chromium, lead, nickel, silver, and zinc) as the primary groundwater contaminants. SVOCs were also detected infrequently at low concentrations. A DGI was conducted to confirm the historic results. TCE was not detected in the DGI groundwater samples. Chromium, lead, nickel, and silver were either not detected or detected at much lower concentrations during the DGI. The DGI results showed that the previous results were anomalies that may have been caused by the groundwater sampling technique used to collect the samples.

<u>Site 18</u>

No VOCs, SVOCs, pesticides, or PCBs were detected in the groundwater samples collected at Site 18. Aluminum, beryllium, calcium, iron, magnesium, manganese, potassium, and sodium were detected at concentrations less than background levels except beryllium, which was less than the risk-based COPC screening level (Region 9 PRG) and CTDEP SWPC.

<u>Site 20</u>

The overburden and bedrock groundwater at Site 20 was characterized during three separate investigations. VOCs and SVOCs were detected sporadically at low concentrations in the overburden and bedrock groundwater during the investigations. Naturally occurring metals were detected consistently in the groundwater.

<u>Sites 9 and 23</u>

The results of the four quarterly sampling events indicate that groundwater from Site 23 (which includes Site 9) being collected and conveyed in the storm sewer system does not pose a significant risk to human health or the environment under current and expected future land use (non-residential).

2.6 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

NSB-NLON is currently an active Navy base and is expected to remain so into the foreseeable future. Reasonably anticipated future land uses of Sites 2A, 2B, 3, 7, 14, 15, 18, 20, and 23 include continued use for their current Naval functions.

Sites 2A, 2B, 3, 7, and 14 are located within designated ESQD arcs of Site 20; therefore, further development is not planned for this area. Navy regulations prohibit construction of inhabited buildings or structures within these arcs and, although existing buildings operate under a waiver of these regulations, no further construction or residential development is planned for of these sites.

Groundwater in the overburden and bedrock at Sites 2A, 2B, 3, 7, 14, 15, 18, 20, and 23 is classified as GB by the State of Connecticut. Based on the GB classification, the groundwater is presumed not suitable for human consumption without treatment. Neither aquifer is currently used as a source of drinking water or for industrial water supply purposes, and there are no current plans to use either aquifer in the future for drinking water or industrial water supply purposes. The overburden groundwater discharges locally to streams that eventually discharge to the Thames River or directly to the Thames River. The overburden aquifer is hydraulically connected to the bedrock aquifer.

2.7 SUMMARY OF SITE RISKS

The purpose of a risk assessment is to estimate the probability and magnitude of potential adverse human health and environmental effects from exposure to contaminated media at a site. The results of the risk assessment provide the basis for taking action and identify the contaminants and exposure pathways that need to be addressed by the RA.

The human health risks associated with exposure to OU9 groundwater were evaluated as part of the following investigations:

- Phase II RI (B&RE, 1997) – Sites 2, 3, 7, 14, 15, and 20
- BGOURI (TtNUS, 2002a) – Sites 2A, 3, 7, 14, 15, 18, 20, and 23
- BGOURI Update/FS (TtNUS, 2004) – Sites 3, 7, 14, 15, and 20

In addition, human health risk assessment (HHRA) results for Sites 2 and 23 were re-evaluated in 2008 to evaluate the effects of more recent data and updated guidance. The HHRA memoranda describing these updates are included in Appendix E of this ROD. Also in Appendix E is a 2008 memorandum evaluating risks from vapor intrusion of VOCs from groundwater into the indoor air of current industrial and potential future residential buildings on OU9 sites. The HHRA for Site 20 was also updated in 2008 to evaluate the effects of more recent data and updated guidance. The results of the Site 20 re-evaluation are provided in Appendix F.

Ecological risk assessments were conducted for Sites 2A and 2B as part of the Phase II RI and the ongoing Phase III investigation. Potential ecological risks associated with Site 3 - NSA groundwater after discharging to a surface water body were evaluated in the BGOURI Update/FS.

The results of these risk assessments, as relevant to Sites 2A, 2B, 3, 7, 9, 14, 15, 18, 20 and 23 groundwater, are provided below and tabulated as follows.

Summary of Cancer Risks and Hazard Indices

Risk	Site 2A	Site 2B	Site 3	Site 7
Construction Workers – Direct Exposure				
Cancer Risk	1.2 per 100,000,000	3.3 per 100,000,000	1.3 per 1,000,000	4.2 per 10,000,000
Hazard Index	0.006	0.2	0.001	0.09
Adult Residents – Direct Exposure				
Cancer Risk	3.3 per 10,000	NA	1.4 per 1000	6.4 per 10,000
Hazard Index	6.4	NA	2.4	5.6
Industrial Workers – Vapor Intrusion				
Cancer Risk	1.1 per 1,000,000,000	1.4 per 100,000,000	2.3 per 1,000,000	6.2 per 1,000,000,000
Hazard Index	0.000003	0.00003	0.01	0.00001
Adult Residents – Vapor Intrusion				
Cancer Risk	7.8 per 1,000,000,000	9.8 per 100,000,000	1.6 per 100,000	4.2 per 100,000,000
Hazard Index	0.00002	0.0001	0.06	0.00008

Risk	Site 15	Sites 14 and 18	Site 20	Sites 9 and 23
Construction Workers – Direct Exposure				
Cancer Risk	No COPCs	No COPCs	1.2 per 100,000,000	8.8 per 100,000,000
Hazard Index	0.002	No COPCs	0.0002	0.2
Adult Residents – Direct Exposure				
Cancer Risk	No COPCs	No COPCs	6.5 per 100,000	2.6 per 10,000
Hazard Index	0.3	No COPCs	0.3	13
Industrial Workers – Vapor Intrusion				
Cancer Risk	5.1 per 10,000,000	No COPCs	1.1 per 100,000,000	3.4 per 10,000,000
Hazard Index	0.001	No COPCs	0.00003	0.0008
Adult Residents – Vapor Intrusion				
Cancer Risk	3.5 per 1,000,000	No COPCs	7.4 per 100,000,000	2.3 per 1,000,000
Hazard Index	0.007	No COPCs	0.0001	0.005

NA - Not applicable. A residential scenario was not evaluated because Site 2B is a wetland.

No COPCs - Maximum concentrations of all chemicals were less than the screening criteria; therefore, no evaluation was required.

2.7.1 Human Health Risk Assessment

The major components of a HHRA include data evaluation, exposure assessment, toxicity assessment, risk characterization, and uncertainty analysis. Data evaluation is a task that uses a variety of information to determine which of the chemicals detected in site media are most likely to present a risk to potential receptors. The end result of the evaluation is a list of COPCs and representative exposure point concentrations for each medium. During the exposure assessment, potential human exposure pathways are identified at the source areas under consideration. Chemical-specific toxicity criteria for the identified COPCs are identified during the toxicity assessment and are used in the quantification of potential human health risks. Risk characterization involves quantifying the risks associated with exposure to the COPCs using algorithms established by EPA and CTDEP. Risks from chemicals are calculated for either carcinogenic or noncarcinogenic effects. The uncertainty analysis identifies limitations in the risk assessment that might affect the final risk results. The final result of the risk assessment is the identification of medium-specific COCs and exposure pathways that need to be addressed by an RA.

For the Phase II RI HHRA, COPCs for groundwater were identified by comparing maximum concentrations to EPA Region 3 Risk-Based Concentrations (RBCs) for tap water ingestion. For the BGOURI and BGOURI Update/FS, COPCs for groundwater were identified by comparing maximum detected concentrations of contaminants to EPA Region 9 Preliminary Remediation Goals (PRGs) for tap water, Region 3 RBCs for tap water, CTDEP Groundwater Protection Criteria (GA/GAA), EPA Maximum Contaminant Levels (MCLs), Connecticut MCLs, CTDEP RSRs for migration of groundwater to surface water, CTDEP RSRs for volatilization from groundwater to indoor air, and background concentrations. If the maximum concentration exceeded any criterion, the chemical was retained as a COPC for all associated exposure routes.

Potential receptors for the HHRAs for exposures to groundwater included construction workers and future adult residents, with the exception of the Phase II HHRA, which only evaluated potential exposures to groundwater for construction workers. Future residential receptors were evaluated only to provide an indication of potential risks if the facility was closed and subsequently developed for residential use. Potential exposure pathways are summarized in Table 2-7. These pathways consider the potential for exposure based on present use, potential future use, and location of the sites. Exposure assumptions for the receptors and toxicity information for the COPCs were presented in the Phase II RI (B&RE, 1997), BGOURI (TtNUS, 2002a), and BGOURI Update/FS (TtNUS, 2004) and are not reiterated in this ROD.

Exposure point concentrations for each of the COPCs were developed for reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios. For the Phase II and BGOURI HHRAs, the maximum and average concentrations were used for the groundwater exposure point concentrations under the RME and CTE scenarios, respectively. Based on the limited data set in the BGOURI Update/FS, the maximum detected concentration was used as the groundwater exposure point concentration under the RME and CTE scenarios.

Potential human health risks resulting from exposure to COPCs were estimated using algorithms established by EPA and CTDEP. The algorithms are used to calculate risk as a function of chemical concentration, human exposure parameters, and toxicity. Risks attributable to exposure to chemical carcinogens were estimated as the probability of an individual developing cancer over a lifetime [incremental cancer risk (ICR)]. According to EPA, risks less than 1 x 10^{-6} (or a risk of less than one in one million) are generally considered to be “acceptable," and risks greater than 1 x 10^{-4} (1 in 10,000) are generally considered to be “unacceptable." According to CTDEP, risks less than 1 x 10^{-5} (1 in 100,000) for cumulate risk or 1 x 10^{-6} (1 in 1,000,000) for individual chemicals are generally considered to be “acceptable," while risks greater than 1 x 10^{-5} for cumulative risk or 1 x 10^{-6} for individual chemicals are generally considered to be “unacceptable." The hazards associated with the effects of noncarcinogenic chemicals were evaluated by comparing an exposure level or intake to a reference dose. If the ratio of the intake of a chemical to the reference dose [hazard quotient (HQ)] exceeds unity, noncarcinogenic (toxic) effects may occur. A hazard index (HI) was generated by summing the individual HQs for all the COPCs associated with a specific pathway. If the value of the HI exceeds unity, noncarcinogenic health effects associated with that particular chemical mixture may occur, and therefore it is necessary to segregate the HQs by target organ effects or mechanism of action. The HQ should not be construed as a probability in the manner of the ICR, but rather as a numerical indicator of the extent to which a predicted intake exceeds or is less than a reference dose (RfD). The results of the HHRAs for Sites 2, 3, 7, 14, 15, 18, 20, and 23 (which includes Site 9) are discussed below.

2.7.1.1 Site 2

Human health risks associated with Site 2 groundwater were evaluated during the Phase II RI and BGOURI (Site 2A only) and were re-evaluated in a 2008 technical memorandum based on changes to risk assessment guidance and collection of additional data.

The HHRA for Site 2B groundwater performed as part of the Phase II RI evaluated cancer and non-cancer risks for current and future construction workers (the only receptor expected to be exposed to site groundwater under current and reasonably anticipated future land uses). The estimated cancer risk of 4 x 10^{-7} for construction workers was less than EPA’s target risk range and CTDEP’s target risk. The cumulative non-cancer risk associated with exposure to groundwater for the construction worker was less than the EPA and CTDEP acceptable level of 1.0 for the CTE scenario but exceeded 1.0 for the RME scenario. The elevated non-cancer hazard was primarily attributed to dermal exposure to manganese, which is relatively abundant in the environment. The chemical-specific risk for manganese via dermal contact (1.7) slightly exceeded 1.0 and was based on very conservative exposure assumptions (exposure of construction workers to groundwater for 8 hours per day for 120 days per year). A re-evaluation of manganese data based on more realistic exposure assumptions (4 hours per day for 30 days) results in an HI of 0.2, less than the EPA and CTDEP acceptable level.

The results of the Phase II RI risk assessment for Site 2A indicated potentially unacceptable cancer and non-cancer risks based on exposure of construction workers to groundwater at the site. However, this risk assessment was conducted using data collected prior to capping of the landfill. The risk assessment was updated as part of the BGOURI, as discussed below.

Potential groundwater receptors evaluated included only construction workers potentially exposed to groundwater via dermal contact while excavating building foundations. Because of the nature of the site (i.e., a covered former landfill), a future residential exposure scenario was not considered. Maximum and average concentrations were used to represent exposure point concentrations for the RME and CTE scenarios, respectively. No carcinogenic toxicity factors were available for the identified COPCs; consequently, cancer risks were not estimated for construction workers exposed to groundwater. HIs for construction workers exposed to groundwater were 0.00008 and 0.00004 for the RME and CTE scenarios, respectively, less than EPA's and CTDEP's acceptable level of 1.0.

The HHRA conducted for Site 2 groundwater during the BGOURI was re-evaluated in 2008 to determine if changes in EPA and CTDEP risk assessment guidance and recently collected groundwater data (August and December 2006 groundwater monitoring results) affected the risk assessment conclusions. The most recent VOC data were also re-evaluated to estimate risks associated with vapor intrusion. The following is a summary of the results of these re-evaluations:

- The HHRA for Site 2A prepared during the BGOURI evaluated potential risks from exposures to groundwater by construction workers. The HHRA determined that risks for construction workers were within USEPA and CTDEP acceptable levels. Potential risks for construction workers exposed to Site 2A groundwater would still be acceptable using the analytical results from the most recent rounds of groundwater sampling.

- Risks to hypothetical future residents using Site 2 groundwater as a drinking water supply would exceed USEPA and CTDEP acceptable levels, although residential development of Site 2A is prohibited.

- The vapor intrusion evaluation for groundwater determined that risks from vapor intrusion were within USEPA and CTDEP acceptable levels for residential and industrial scenarios. The evaluation concluded that no further action was required for vapor intrusion issues at Site 2.

The memoranda for these re-evaluations are included in Appendix E.

2.7.1.2 Site 3

The BGOURI Update/FS HHRA evaluated risks from exposure to Site 3 groundwater for construction workers and hypothetical future adult residents. Dermal contact with groundwater was the exposure route evaluated for construction workers, and exposures to groundwater through direct ingestion, dermal contact while showering/bathing, and inhalation of volatiles while showering/bathing were evaluated for hypothetical adult residents.

Tables 2-8 and 2-9 present the risk estimates from the BGOURI Update/FS HHRA for Site 3 under the RME and CTE scenarios, respectively. Although not presented in Tables 2-8 and 2-9, the risk estimates from the Phase II HHRA and BGOURI HHRA are comparable to those presented in the BGOURI Update/FS HHRA. Risk Assessment Guidance for Superfund (RAGS) Part D tables for Site 3 (Summary of Receptor Risks and Hazards for COPCs) are included in Appendix F.

Cumulative ICRs and HIs for exposures to groundwater by construction workers were within the EPA and CTDEP acceptable ranges for both the RME and CTE scenarios. ICRs and HIs exceeded the EPA and CTDEP acceptable ranges for hypothetical adult residents under the RME and CTE scenarios. Carcinogenic PAHs, VC, and arsenic were the major contributors to the unacceptable risks. These risks are subject to several sources of uncertainty as discussed below.

Carcinogenic PAHs were only detected in one groundwater sample, which was collected from a temporary monitoring well. The turbidity associated with this groundwater sample was elevated: consequently, the carcinogenic PAHs detected in the groundwater sample from this well are believed to be associated with suspended solids in the groundwater sample and are not believed to be dissolved constituents in groundwater. Therefore, the cancer risks presented in the HHRA for exposures to carcinogenic PAHs in groundwater were determined to be overestimated and not representative of actual site risks. PAHs were not retained as final COCs for Site 3 groundwater.

Arsenic was only detected in two of eight groundwater samples collected during the DGI. The concentrations of dissolved arsenic in the groundwater samples are comparable to the background dissolved arsenic concentration. It is likely that the elevated arsenic concentration detected in one unfiltered groundwater sample (2DMW29S) is related to the suspended solids in the groundwater sample. Therefore, the carcinogenic and noncarcinogenic risks presented in the HHRA for exposures to arsenic in groundwater were determined to be overestimated and not representative of actual site risks. Arsenic was not retained as a final COC for Site 3 groundwater.

1,1,2-Trichloroethene and alpha-BHC were only detected once in groundwater samples collected from temporary wells. The 1,1,2-trichlroethane concentration was less than federal and State MCLs and the

CTDEP RSR. No other criteria were available to evaluate the detection of alpha-BHC. The risk associated with alpha-BHC (dermal = 2.1×10^{-6} and ingestion = 1.2×10^{-6}) marginally exceeded CTDEP's 1×10^{-6} risk level for individual chemicals. Based on the low frequencies of detections, the uncertainty associated with data from temporary wells, and the marginal risks associated with the two chemicals, 1,1,2-trichloroethene and alpha-BHC were determined not be COCs for Site 3 groundwater.

Although estimated risks from exposure to concentrations of TCE in groundwater from Site 3 did not exceed acceptable levels, TCE was included as a final COC for Site 3 groundwater because it was detected at concentrations that exceeded federal and state MCLs and the CTDEP RSR. Therefore, based on the results of the risk assessment and comparisons to risk-based criteria, COCs for Site 3 groundwater include TCE and VC.

Groundwater data from the Year 1 Annual Groundwater Monitoring Report for Sites 3 and 7 (TtNUS, 2007) were used to evaluate the potential for vapor intrusion at Site 3 (see Appendix E.3). Based on comparisons of detected VOC concentrations to EPA and CTDEP screening criteria for vapor intrusion, chloroform, TCE, and VC were retained for further evaluation using the Johnson and Ettinger Vapor Intrusion Model (EPA, 2004). Modeling results showed that cancer risks and hazard indices for residential and industrial scenarios did not exceed EPA acceptable levels. Cancer risks for chloroform and VC for residential exposures exceeded CTDEP acceptable risk levels. Cancer risks for TCE based on California Environmental Protection Agency toxicity criteria (as recommended by EPA Region 1) were within CTDEP acceptable levels for residential and industrial scenarios, but cancer risks based on draft EPA toxicity criteria exceeded CTDEP acceptable levels.

The Johnson and Ettinger Vapor Model was also used to calculate site-specific, risk-based, residential and industrial PRGs and CTDEP RSRs for vapor intrusion. The maximum detected concentration of chloroform exceeds the site-specific PRG for residential exposures but is less than the site-specific PRG for industrial exposures, EPA MCL, and CTDEP RSRs for vapor intrusion. Because the modeling only showed potential cancer risks exceeding CTDEP acceptable levels and because the maximum chloroform concentration did not exceed CTDEP RSRs for vapor intrusion, it is determined that there are no vapor intrusion issues associated with chloroform and no further action is required. The maximum detected concentration of TCE exceeds the EPA MCL but is less than the site-specific PRGs and CTDEP RSRs for vapor intrusion. A groundwater monitoring program and LUCs are in place to address the exceedance of the EPA MCL for trichloroethene. Therefore, no further action is required for vapor intrusion issues associated with TCE.

The maximum detected concentration of VC (at well 2DMW29S) exceeds the EPA MCL, site-specific PRGs, and residential CTDEP RSR for vapor intrusion. A groundwater monitoring program and LUCs are in place to address the exceedance of the EPA MCL for VC. Based on comparisons to CTDEP RSRs for vapor intrusion, the VC concentration detected in groundwater at monitoring well 2DMW29S does not represent a vapor intrusion issue under the current industrial scenario but may be an issue under a future residential scenario. Risks associated with a building constructed in the vicinity of monitoring well 2DMW29S for industrial purposes would be acceptable; however, associated risks for a building within 100 feet of 2DMW29S for residential use would be unacceptable unless steps were taken to mitigate vapor intrusion.

2.7.1.3 Site 7

The BGOURI Update/FS HHRA evaluated risks from exposure to Site 7 groundwater for construction workers and hypothetical future adult residents. Dermal contact with groundwater was the exposure route evaluated for construction workers, and exposures to groundwater through direct ingestion, dermal contact while showering/bathing, and inhalation of volatiles while showering/bathing were evaluated for hypothetical adult residents.

Tables 2-10 and 2-11 present the risk estimates from the BGOURI HHRA for Site 7 under the RME and CTE scenarios, respectively. Only the results from the BGOURI HHRA are presented in these tables because no new data were collected during the DGI for the BGOURI Update and no changes to the HHRA were made during the BGOURI Update. Although not presented in Tables 2-10 and 2-11, the risk estimates from the Phase II HHRA are comparable to those presented in the BGOURI HHRA. RAGS Part D tables for Site 7 (Summary of Receptor Risks and Hazards for COPCs) are included in Appendix F.

Cumulative ICRs and HIs resulting from exposure to groundwater by construction workers were within EPA and CTDEP acceptable ranges for both the RME and CTE scenarios. ICRs and HIs exceeded EPA and CTDEP acceptable ranges for hypothetical adult residents under the RME and CTE scenarios. Benzene, bis(2-ethylhexyl) phthalate, HCB, 1,4-DCB, TCE, arsenic, and chromium were the major contributors to the unacceptable risks. These risks are subject to several sources of uncertainty as discussed below.

Bis(2-ethylhexyl) phthalate was detected infrequently in groundwater and is a common laboratory contaminant is typically associated with plastics (well casings, plastic bottleware, etc). It is unlikely that the detections of bis(2-ethylhexyl) phthalate are associated with a Site 7 source. Based on this information, it was determined that the elevated risks from exposures to bis(2-ethylhexyl) phthalate were overestimated and limited to a small section of Site 7. Bis(2-ethylhexyl) phthalate was not retained as a final COC for site 7 groundwater.

Arsenic and chromium were detected infrequently in groundwater samples collected during the BGOURI. Detected concentrations of arsenic were less than the Connecticut MCL in all samples and only exceeded the EPA MCL in the sample from temporary monitoring well 7TW09. Detected concentrations of chromium only exceeded the EPA MCL and Connecticut MCL in the groundwater sample from temporary monitoring well 7TW09. The detected concentrations of most other metals were significantly higher in the sample from temporary monitoring well 7TW09 compared to concentrations in samples from other monitoring wells. The total suspended solids content in the groundwater sample from 7TW09 was two orders of magnitude greater than in any of the groundwater samples from the other wells. It is likely that the elevated arsenic and chromium concentrations detected in the groundwater sample from 7TW09 are related to the suspended solids in the groundwater sample and are not believed to be dissolved constituents in groundwater. Therefore, the cancer risks and HIs presented for arsenic and chromium were determined to be overestimated and not representative of actual site risks. Arsenic and chromium were not retained as final COCs for Site 7 groundwater.

Although estimated risks from exposure to concentrations of CB in groundwater from Site 7 did not exceed acceptable levels, CB was included as a final COC for Site 7 groundwater because it was detected at concentrations that exceeded federal and state MCLs and the CTDEP RSR. Therefore, based on the results of the risk assessment and comparisons to risk-based criteria, COCs for Site 7 groundwater include benzene, CB, 1,4-DCB, HCB, and TCE.

The results of the 2008 vapor intrusion evaluation indicated that NFA is required for vapor intrusion issues at Site 7 (see Appendix E.3).

2.7.1.4 Site 14

The BGOURI Update/FS HHRA evaluated risks from exposure to Site 14 groundwater for construction workers and hypothetical future adult residents. Dermal contact with groundwater was the exposure route evaluated for construction workers, and exposures to groundwater through direct ingestion, dermal contact while showering/bathing, and inhalation of volatiles while showering/bathing were evaluated for hypothetical adult residents.

A summary of Site 14 groundwater data from the BGOURI Update/FS is presented in Table 2-12. Concentrations of all chemicals in Site 14 groundwater were less than all available screening criteria and basewide background levels. Iron and manganese concentrations exceeded secondary MCLs; however, secondary MCLs are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water and are not associated with unacceptable health risks. Consequently, no COCs were retained for Site 14 groundwater, and no adverse health effects are anticipated from exposure to Site 14 groundwater.

The results of the 2008 vapor intrusion evaluation indicated that NFA is required for vapor intrusion issues at Site 14 (see Appendix E.3).

2.7.1.5 Site 15

The BGOURI Update/FS HHRA evaluated risks from exposure to Site 15 groundwater for construction workers and hypothetical future adult residents. Dermal contact with groundwater was the exposure route evaluated for construction workers, and exposures to groundwater through direct ingestion, dermal contact while showering/bathing, and inhalation of volatiles while showering/bathing were evaluated for hypothetical adult residents.

Tables 2-13 and 2-14 present the risk estimates from the BGOURI Update/FS HHRA for Site 15 under the RME and CTE scenarios, respectively. RAGS Part D tables for Site 15 (Summary of Receptor Risks and Hazards for COPCs) are included in Appendix F.

No carcinogenic COPCs were identified in groundwater; therefore, no ICRs were calculated for exposures to groundwater. HIs for exposures to groundwater by construction workers and future adult residents were within the EPA and CTDEP acceptable ranges for both the RME and CTE scenarios. Consequently, no COCs were retained for Site 15 groundwater, and no adverse health effects are anticipated from exposure to Site 15 groundwater.

The results of the 2008 vapor intrusion evaluation indicated that NFA is required for vapor intrusion issues at Site 15 (see Appendix E.3).

2.7.1.6 Site 18

The Site 18 groundwater COPCs and the screening criteria used to identify them are summarized in Tables 2-15 and 2-16. No human health COPCs were identified for groundwater; therefore, no ICRs and HIs were calculated for exposures to groundwater.

Manganese in groundwater was the only chemical with a maximum detected concentration that exceeded its direct contact screening criteria but was not retained as a COPC based on a comparison to background levels. Exposures to groundwater were not evaluated in the HHRA because no COPCs were identified for groundwater at Site 18, although potential receptors for exposures to groundwater would be construction workers and adult residents. Potential risks from dermal exposures to manganese in water are insignificant (EPA, 2001); consequently, the elimination of manganese as a COC on the basis of background would not affect risk estimates for the construction worker because this receptor would only be evaluated for dermal exposures to groundwater. Potential exposure pathways for future adult residents include ingestion and dermal contact with groundwater. If exposure to manganese in groundwater by a future adult resident were evaluated in the HHRA, the resulting HQ for manganese would be 0.4, which is less than the EPA and CTDEP acceptable level of 1.0, indicating that no adverse health effects are anticipated for adult residents exposed to manganese in groundwater at Site 18.

The HHRA, data screening results, and uncertainty analysis showed that there are no groundwater COCs for Site 18, and no adverse health effects are anticipated form exposure to Site 18 groundwater.

Because no VOCs were detected in groundwater samples collected at Site 18 during the BGOURI, vapor intrusion is not an issue at the site.

2.7.1.7 Site 20

Risks from exposures to Site 20 groundwater for construction workers and hypothetical adult residents were evaluated in the Phase II HHRA and BGOURI HHRA. A screening risk evaluation was presented in the BGOURI Update/FS, although the data set from the BGOURI Update/FS only included metals. In 2008, the risks for exposures to groundwater at Site 20 were re-evaluated using the most recent data set, which consisted of organic sample results from the BGOURI and inorganic sample results from the DGI. The re-evaluation estimated risks from exposure to Site 20 groundwater for construction workers and hypothetical future adult residents. Dermal contact with groundwater and inhalation of volatiles were the exposure routes evaluated for construction workers, and exposures to groundwater through direct ingestion, dermal contact while showering/bathing, and inhalation of volatiles while showering/bathing were evaluated for hypothetical adult residents.

Tables 2-15 and 2-16 present the latest risk estimates for the combined DGI and BGOURI groundwater data set under the RME and CTE scenarios, respectively. RAGS Part D tables for Site 20 (Summary of Receptor Risks and Hazards for COPCs) are included in Appendix F. Cumulative ICRs and HIs for exposures to groundwater by construction workers were within EPA and CTDEP acceptable risk ranges for both the RME and CTE scenarios. For hypothetical adult residents, cumulative ICRs and HIs were within EPA acceptable risk ranges for both the RME and CTE scenarios. ICRs for hypothetical adult residents exceeded the CTDEP acceptable risk level of 10^{-5} for cumulative exposures under the RME scenario and the CTDEP acceptable level of 10^{-6} for individual chemicals under the CTE scenario. Benzo(a)pyrene and arsenic were the major contributors to the unacceptable CTDEP risks. The risks estimated in the re-evaluation are subject to several sources of uncertainty as discussed below.

ICRs for benzo(a)pyrene and arsenic exceeded CTDEP acceptable levels in the risk re-evaluation. Benzo(a)pyrene was not detected in groundwater samples collected during the Phase II RI and was only detected in one groundwater sample collected during the BGOURI. The detected concentration of benzo(a)pyrene (0.05 µg/L) was less than the federal MCL (0.2 µg/L) and the Connecticut GA/GAA groundwater criterion (0.2 µg/L). Therefore, benzo(a)pyrene was not considered as a COC in Site 20 groundwater.

The concentration of arsenic in one well (2WCMW1S) during the DGI was near the background concentration and less than the federal MCL, Connecticut GA/GAA groundwater criterion, and Connecticut MCL. Arsenic is known to be related to dredge spoils in the area, and it is not likely to be related to a Site 20 source. Consequently, arsenic was not retained as a COC for groundwater at Site 20. Therefore, no COCs for direct contact exposures to groundwater at Site 20 were identified, and no adverse health effects are anticipated from exposure to Site 20 groundwater.

The results of the 2008 vapor intrusion evaluation indicated that NFA is required for vapor intrusion issues at Site 20 (see Appendix E.3).

2.7.1.8 Site 23

Human health risks associated with groundwater at Site 23 were evaluated during the BGOURI (TtNUS, 2002) and were re-evaluated in a 2008 technical memorandum based on changes to risk assessment guidance and collection of additional data.

Maximum detected concentrations of PCE, naphthalene, and lead in groundwater during the BGOURI exceeded risk-based screening levels (Region 9 PRGs) and were retained as COPCs.

ICRs for construction workers exposed to groundwater were 1.3×10^{-9} and 1.1×10^{-10} for the RME and CTE scenarios, respectively, which are less than USEPA's target risk range of 10^{-4} to 10^{-6} and CTDEP's acceptable risk level of 10^{-5} for cumulative exposures. The ICRs for future adult residents exposed to groundwater were 4.5×10^{-6} and 1.6×10^{-7} for the RME and CTE scenarios, respectively, which are less than or within USEPA's target risk range and less than CTDEP's acceptable risk level for cumulative exposures. The chemical-specific ICR for tetrachloroethene under the RME scenario exceeded CTDEP's target level of 1×10^{-6} for individual chemicals; however, the maximum detected concentration for tetrachloroethene was less than its CTDEP RSR.

HIs for construction workers exposed to groundwater were 0.0002 and 0.0001 for the RME and CTE scenarios, respectively, which are less than USEPA's and CTDEP's acceptable level of 1.0. HIs for adult residents exposed to groundwater were 0.02 and 0.005 for the RME and CTE scenarios, respectively.

Risks estimated during the BGOURI for the RME scenario at Site 23 are presented in Table 2-17. The conclusions of the HHRA conducted for Site 23 groundwater as part of the BGOURI were as follows:

- Cancer risks for construction workers and non-cancer risks for construction workers and hypothetical future adult residents exposed to groundwater at Site 23 were within USEPA and CTDEP acceptable levels for the RME and CTE scenarios.

- Cancer risks for adult residents exposed to groundwater at Site 23 were less than or within USEPA's target risk range and less than CTDEP's acceptable risk level for cumulative exposures. The chemical-specific cancer risk for PCE exceeded CTDEP's target level of 1×10^{-6} for individual chemicals; however, the maximum detected concentration for tetrachloroethene was less than its CTDEP RSR.

- Because groundwater at Site 23 is not used for human consumption and it is not likely to be used for human consumption in the foreseeable future because of its current classification (i.e., GB groundwater which indicates that it is unsuitable for direct human consumption without treatment), it was determined that an FS was not warranted. However, it was recommended that the decision for preparation of an FS for Site 23 groundwater be postponed until site conditions stabilize and the results of the metering pit sampling and analysis program are evaluated.

The HHRA conducted for Site 23 groundwater during the BGOURI was re-evaluated in 2008 to determine if changes in EPA and CTDEP risk assessment guidance and recently collected groundwater data (data from quarterly underdrain meter pit sampling) affected the risk assessment conclusions (see Appendix E). The following is a summary of the results of the re-evaluation:

- Changes in risk assessment guidance since the BGOURI did not affect the conclusions of the BGOURI risk assessment.

- During the BGOURI, the chemical-specific cancer risk for PCE exceeded CTDEP's target level for individual chemicals, although the maximum detected concentration was less than the CTDEP RSR. Concentrations of tetrachloroethene decreased from 3 µg/L during the BGOURI to 0.4 µg/L during September 2007 metering pit sampling. The chemical-specific risk associated with tetrachloroethene is now less than the CTDEP target level for individual chemicals.

- Concentrations of all chemicals detected in groundwater collected during the first four quarters of underdrain metering pit sampling were less than CTDEP surface water protection and volatilization criteria with the exception of arsenic and several SVOCs. The concentration of total arsenic in the sample collected in September 2007 exceeded the surface water protection criterion, although the concentration of arsenic in the filtered sample was less than the criterion. Arsenic detected in the unfiltered sample is believed to be a result of suspended solid particles in the water, and the filtered sample is more indicative of groundwater quality. Concentrations of six PAHs and hexachlorobenzene exceeded surface water protection criteria in December 2007; however, these chemicals were not detected in the duplicate sample and were not detected in February 2008.

- Potential risks for construction workers exposed to Site 23 groundwater would still be acceptable using the analytical results from the most recent rounds of groundwater sampling. Potential risks for hypothetical residents exposed to Site 23 groundwater exceed acceptable levels, but Site 23 is not suitable for residential development (based on petroleum cleanup to industrial standards and GB groundwater classification).

- The vapor intrusion evaluation for Site 23 groundwater determined that risks from vapor intrusion did not exceed EPA and CTDEP acceptable levels for residential and industrial scenarios. The evaluation concluded that no further action was required for vapor intrusion issues at Site 23.

- Based on existing information, Site 23 groundwater does not pose a significant threat to human health or the environment under current and expected future land use. Adverse health effects are possible under hypothetical future residential land use.

2.7.2 Summary of Ecological Risk Assessment

An ERA for Site 3 groundwater at the NSA was performed for the BGOURI Update/FS. A summary of this ERA is presented in the following subsections. Ecological risks for the remaining portions of Site 3 and Sites 7, 14, and 20 were evaluated during the Phase II RI. Groundwater was not identified as an ecological issue at those sites. No ecological risk assessments were performed at Sites 15 or 18 because there were no ecological issues identified at the sites. Site 15 is located within a paved parking area and Site 18 is a building. Both sites are in well developed portions of NSB-NLON and neither provide habitats suitable for supporting a wildlife population.

2.7.2.1 Site 2

The Area A Landfill, Site 2A, currently represents generally limited habitat due to the pavement covering the landfill and its proximity to areas of high human activity (e.g., Area A Weapons Center). Site 2A does border areas that represent potential wildlife habitat or may provide cover for ecological receptors. An ecological risk assessment was conducted as part of the Phase II RI (conducted in 1993 and 1994) and considered site conditions prior to construction of the landfill cap in 1997. Based on conditions after capping, the Phase II RI concluded that the Area A Landfill represents little potential risk to ecological receptors.

Exposure of ecological receptors to groundwater or surface water affected by groundwater was not expected and was therefore not evaluated in the ecological risk assessment for Site 2A. Groundwater from Site 2A discharges to surface water in the Area A Wetland (Site 2B), and surface water contamination at Site 2B was evaluated in the ecological risk assessment for this site, which was also conducted as part of the Phase II RI.

Using conservative exposure assumptions, maximum and average chemical concentrations in surface water, sediment, and soil at Site 2B were compared to benchmark values protective of various terrestrial and aquatic receptors. The results of these comparisons indicated that chemicals associated with these media at Site 2B could adversely impact aquatic biota, terrestrial vegetation, soil invertebrates, and terrestrial vertebrates. These risks are being evaluated and will be addressed as necessary under OU12, Site 2B sediment, as part of the Phase III RI.

2.7.2.2 Site 3

Introduction

The goal of the ERA was to determine whether adverse ecological impacts are present as a result of exposure to chemicals released to the environment at Site 3 - NSA. The ERA methodology used was the Final Guidelines for Ecological Risk Assessment (EPA, 1998), the Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (EPA, 1997), and Navy Policy for Conducting Ecological Risk Assessments (Navy, 1999b). The ERA consisted of Steps 1, 2, and 3a of the ERA process. A summary of the ERA conducted for the groundwater at Site 3 is provided below.

Exposure Assessment

A general description of Site 3 is presented in Section 2.5 of this ROD. Site 3 – NSA, located adjacent to Stream 5 in the northern portion of Site 3, is very small and consists primarily of a steep embankment. The embankment slopes to an intermittent stream (Stream 5) separated from Triton Road by a narrow strip of grassed land (approximately 10 to 15 feet wide). The embankment is covered by large rocks, boulders, and small trees. Figure 2-20 presents the conceptual site model. In summary, the primary source of contamination was assumed to originate at the surface. It is likely that the contamination migrated through the soil to groundwater. In addition, contamination that migrated to groundwater could have discharged to Stream 5. There is also a possibility that contamination could have migrated to Stream 5 sediment as a result of erosion of the embankment. Ecological receptors can be exposed to contaminants in the surface water, sediment, and surface soil by direct exposure, ingestion of media, and ingestion of contaminated food items.

Assessment and Measurement Endpoints

For the ERA, the assessment endpoint associated with exposure to groundwater included the protection of aquatic invertebrates from a reduction in growth, survival, and/or reproduction caused by site-related chemicals.

The following measurement endpoint was used to evaluate the assessment endpoint in this ERA:

- Decreases in survival, growth, and/or reproduction of aquatic invertebrates were evaluated by comparing the measured concentrations of chemicals in the groundwater to surface water screening values designed to be protective of these ecological receptors. Groundwater sample concentrations were compared to surface water screening values as a conservative measure to evaluate the potential migration pathway of groundwater discharge to Stream 5.

Identification of Chemicals of Potential Concern

Potential risks to aquatic receptors resulting from exposure to chemicals were evaluated by comparing the chemical concentrations in the groundwater to screening levels. Table 2-18 presents the sources of the screening levels. An ecological effects quotient (EEQ) approach was used to characterize the risk to potential ecological receptors. This approach characterizes potential effects by comparing exposure concentrations to effects data. The EEQs for aquatic receptors were calculated as follows:

$$EEQ = \frac{C_{sw}}{SwSV}$$

where:

EEQ = Ecological effects quotient (unitless)
C_{sw} = Contaminant concentration in surface water (µg/L or mg/L)
SwSV = Surface water receptor screening value (µg/L)

Ecological COPCs were selected by the following procedures:

- Chemicals with EEQs greater than 1.0 (using maximum concentrations) were retained as COPCs for further evaluation because they have a potential to cause risk to ecological receptors.

- Contaminants without screening levels were retained as COPCs but were only evaluated qualitatively.

One VOC, five SVOCs, seven total metals, and three filtered metals were retained as COPCs in groundwater for the potential future exposure scenario of migration to surface water in Stream 5 (Table 2-18). Benzo(a)pyrene, aluminum, barium, copper, iron, lead, and manganese were retained as COPCs because their maximum concentrations exceeded associated surface water screening values (SwSVs). All other chemicals were retained as COPCs because no toxicity information was available for comparison.

<u>Step 3A – Refinement of Conservative Exposure Assumptions</u>

Step 3a consists of a refinement of the conservative exposure assumptions used to select COPCs to more realistically estimate potential risks to ecological receptors. This refinement is qualitative in nature and discusses items such as habitat, exposure concentrations, and alternate benchmarks. The chemicals discussed in the following paragraphs were retained as COPCs because their maximum detections in groundwater exceeded SwSVs or because SwSVs were not available for comparison.

VC was retained as a COPC because no SwSV was available for comparison to the maximum groundwater concentration. It should be noted, however, that VOCs are typically not detected in surface water samples due to their high degree of volatility. Also, based on SwSVs for the other VOCs, VC is not expected to be detected in groundwater at sufficient concentrations to cause ecological risks to aquatic receptors if discharged to Stream 5. VC was not retained as a COC.

Benzo(a)pyrene was retained as a COPC because the single detected concentration exceeded the conservative SwSV. However, the SwSV seems overly conservative when compared to SwSVs for other PAHs from different sources (e.g., SwSV for acenaphthene is 23 µg/L, SwSV for fluorene is 3.9 µg/L). Additionally, benzo(a)pyrene was detected in only one of five groundwater samples (i.e., the sample from 3TW28). At such a low groundwater concentration, it is unlikely that benzo(a)pyrene would be detected in surface water upon discharge to Stream 5 due to dilution. Benzo(a)pyrene and other PAHs were also detected in the surface soil sample from this location indicating that its presence in groundwater may be attributable to a lack of proper development (turbidity) in this temporary well. Benzo(a)pyrene was not retained as a COC.

Benzo(g,h,i)perylene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene were retained as COPCs because no individual SwSVs were available for comparison. Alternate surface water benchmarks for these PAHs could not be located; therefore, further evaluation of these chemicals was not possible. However, these chemicals were only detected in one of five groundwater samples (i.e., the sample from 3TW28). As with benzo(a)pyrene, these PAHs are unlikely to be detected in surface water upon discharge to Stream 5 due to dilution. These PAHs were also detected in the surface soil sample from this location indicating their presence in groundwater may be attributable to a lack of proper development in this temporary well. For these reasons, benzo(g,h,i)perylene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene were not retained as COCs.

Aluminum, barium, copper, iron, lead, and manganese in total metals samples were retained as COPCs because their maximum detected concentrations in groundwater exceeded corresponding SwSVs. Barium, iron, and manganese were additionally retained as COPCs in filtered metals samples because their maximum filtered groundwater concentrations exceeded associated SwSVs. Vanadium was additionally retained as a COPC because an SwSV was not available for comparison (see Table 2-18).

Aluminum, copper and lead were detected at maximum concentrations in unfiltered groundwater samples that exceeded their respective SwSVs. Vanadium was detected at a maximum concentration that slightly exceeded background. Aluminum, copper, lead, and vanadium were not detected in filtered samples, however, and detections of these metals in unfiltered samples could be attributable to a lack of proper development of the temporary wells. Only concentration levels that occur in filtered samples are considered to be bioavailable to aquatic organisms. For these reasons, these metals are not likely to be present in groundwater at concentrations that would present unacceptable risks to aquatic receptors after migration to surface water. Aluminum, copper, lead, and vanadium were not retained as COCs.

Barium was detected at a maximum concentration of 74.8 µg/L in unfiltered groundwater sample S3GW3TW3001, exceeding the SwSV of 4 µg/L. However, the background concentration of 227 µg/L is nearly three times greater than the maximum groundwater detection, indicating that barium concentrations are naturally occurring and not likely attributable to a contamination source. Barium was also detected in filtered samples at a maximum concentration of 75.6 µg/L, well below the background filtered concentration of 124 µg/L. For these reasons, site-related risks from barium are not considered likely, and barium was not retained as a COC.

Iron was detected at a maximum concentration of 20,000 µg/L in unfiltered groundwater sample S3GW3TW2801, exceeding the SwSV of 1,000 µg/L. However, the maximum concentration is less than the unfiltered background concentration of iron at 28,200 µg/L. Iron was also detected in filtered samples at a maximum concentration of 15,200 µg/L, well below the background filtered concentration of 25,300 µg/L. For these reasons, site-related risks from iron are not considered likely, and iron was not retained as a COC.

Manganese was detected at a maximum concentration of 764 µg/L in groundwater sample S3GW3TW2701, exceeding the SwSV of 120 µg/L. However, the background manganese concentration of 11,700 µg/L is nearly 15 times greater than the maximum detected groundwater concentration. Additionally, manganese was detected in filtered samples at a maximum concentration of 496 µg/L, well below the background filtered concentration of 9,400 µg/L. For these reasons, site-related risks from manganese are not considered likely, and manganese was not retained as a COC.

Summary and Conclusions of Site 3 ERA

Several chemicals detected in groundwater were initially retained as COPCs because their chemical concentrations exceeded screening levels resulting in EEQs greater than 1.0 based on conservative exposure scenarios. These chemicals were then re-evaluated in Step 3a of the ERA to determine which chemicals have the greatest potential for causing risks to ecological receptors, and therefore, should be retained as COCs for further discussion and evaluation. The ecological endpoints evaluated in this ERA were aquatic receptors. In summary, no chemicals were retained as ecological COCs.

2.7.2.3 Site 23

An ecological risk assessment was not conducted for Site 23 groundwater because there are no ecological receptors for groundwater at the site.

2.8 REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) provide a general description of what the response actions will accomplish. These goals typically serve as the design basis for many of the remedial alternatives discussed in the next section. The RAOs provide the basis for evaluating remedial options for Sites 3 and 7 groundwater and an understanding of how the risks identified in the previous section will be addressed by the response actions. No RAOs were necessary for Sites 2, 9, 14, 15, 18, 20, and 23 because there were no unacceptable risks and therefore no remedial actions proposed for the sites.

RAOs were developed to address the COCs detected exclusively at Site 3 (VC) and the COCs detected at both Sites 3 and 7 (TCE and HCB). Separate RAOs were developed to address the COCs detected at Site 7 exclusively (1,4-DCB, benzene, and CB).

2.8.1 Sites 3 and 7 Groundwater RAOs

Sites 3 and 7 groundwater RAOs are as follows:

- RAO A-1: To protect current receptors (construction workers) from incidental exposure to groundwater contaminated with chlorinated hydrocarbons at concentrations greater than PRGs.

- RAO A-2: To protect potential future receptors from regular ingestion (potable water supply) of groundwater contaminated with chlorinated hydrocarbons at concentrations greater than RGs (see Tables 2-19 and 2-20) and to protect future residential receptors from exposure to contaminated groundwater via vapor intrusion (Site 3 only).

- RAO A-3: To protect aquatic ecological receptors by preventing the migration of groundwater contaminated with petroleum hydrocarbons at concentrations greater than PRGs to surface water.

2.8.2 Site 7 Groundwater RAOs

Site 7 groundwater RAOs are as follows:

- RAO B-1: Protect current receptors (construction workers) from incidental exposure to groundwater contaminated with organics at concentrations greater than PRGs.

- RAO B-2: Protect potential future receptors from regular ingestion (potable water supply) of groundwater contaminated with benzene and chlorinated hydrocarbons at concentrations greater than RGs.

- RAO B-3: Protect aquatic ecological receptors by preventing the migration of groundwater contaminated with COCs at concentrations greater than PRGs to surface water.

RGs for the protection of potential future receptors are presented in Tables 2-19 and 2-20 for Sites 3 and 7, respectively.

2.8.3 Sites 9 and 23 Groundwater RAOs

RAOs for groundwater at Sites 9 and 23 are as follows:

- RAO C-1: Protect potential future receptors from exposure to contaminated groundwater via ingestion (potable water supply).

- RAO C-2: Protect aquatic ecological receptors.

2.9 DESCRIPTION OF ALTERNATIVES

Separate FSs were prepared to evaluate remedial alternatives for the groundwater contamination identified jointly at Sites 3 and 7 and the groundwater contamination identified exclusively at Site 7. One FS involved development and evaluation of alternatives that would address the COCs detected exclusively at Site 3 (VC) and the COCs detected jointly at Sites 3 and 7 (TCE and HCB). The other FS involved preparation and evaluation of alternatives that addressed the COCs detected exclusively at Site 7 (1,4-DCB, benzene, and CB). No FSs were prepared for Sites 14, 15, 18, and 20 because there were no unacceptable risks and therefore no COCs for the sites. Groundwater at Sites 2A and 2B is currently monitored under the post-closure groundwater monitoring program implemented as part of the remedy for OU1 as required by the September 1995 ROD (Navy, 1995). Institutional controls will remain in place at Sites 2A and 2B as described in the NSB-NLON IR Site Use Restrictions document.

2.9.1 Description of Remedial Alternatives

2.9.1.1 Sites 3 and 7 Groundwater

Alternatives were formulated from the technologies and process options that passed the screening process. The two alternatives selected for detailed evaluation in the FS for combined Sites 3 and 7 groundwater included Alternative GW1-1 (No Action) and Alternative GW1-2 (Institutional Controls with Monitoring). Alternative GW1-1 was evaluated for comparison purposes, and the other alternative was evaluated because of site conditions (generally low concentrations of contaminants, groundwater not classified as a suitable potable water source, and the availability and use of a public water supply) and its ability to meet the RAOs. Active remedial alternatives (e.g., pump and treat) were not considered for Sites 3 and 7 groundwater because they are not effective for the site conditions discussed above.

Alternative GW1-1: No Action

Under this alternative, no activities other than mandatory five-year reviews would be conducted at the sites. The No Action Alternative for groundwater is not expected to be fully protective of human health and the environment. In particular, even though site groundwater is classified as GB, indicating that it is not suitable for regular human consumption, it could potentially be reclassified and used in the future as a potable water supply. Based on the concentrations and sporadic distribution of site groundwater contamination, these risks are possible but not very likely. Also, if groundwater is encountered and removed during construction projects, contaminated groundwater could be discharged to adjacent streams. Based on the concentrations and distribution of groundwater contamination, potential impact to aquatic ecological receptors may not be significant, but potential risks would not be known. This alternative will be retained to serve as a basis for evaluating other alternatives.

- Estimated Time for Design and Construction: NA
- Estimated Time for Operation: 30 years
- Estimated Capital Cost: $0
- Estimated O&M Costs (Present Worth): $89,600
- Estimated Total Present Worth: $89,600

Alternative GW1-2: Institutional Controls with Monitoring

This alternative was developed to protect human health by placing restrictions on groundwater extraction and use at the sites. Under this alternative, institutional controls would be implemented to prohibit the placement of groundwater extraction wells in or use of groundwater from this area without first testing the groundwater. Also, if groundwater is encountered and removed during construction projects (e.g., trench dewatering), the groundwater would have to be characterized and properly handled, discharged, or disposed.

The NSB-NLON IR Site Use Restrictions document would note the location and types of groundwater contamination observed at the sites. Future commercial land use would be permitted as long as institutional controls are maintained. However, at Site 3, construction of a building for residential purposes would be prohibited within 100 feet of well location 2DMW29S unless steps are taken to mitigate vapor intrusion (e.g., subslab depressurization system). In the event of property transfer and with confirmation that contaminated groundwater remains at the sites, an environmental land use restriction pursuant to state law would be used to prohibit the use of groundwater. Compliance monitoring to determine whether there are any violations of institutional control restrictions would also occur.

New and existing monitoring wells would be used to monitor the natural degradation of VOC and SVOC contaminants. Monitoring would continue until contaminant concentrations have decreased below the PRGs and the resulting concentrations are shown to be protective of human health and the environment.

- Estimated Time for Design and Construction: 6 months
- Estimated Time for Operation: 30 years
- Estimated Capital Cost: $59,200
- Estimated O&M Costs (Present Worth): $260,300
- Estimated Total Present Worth: $319,500

2.9.1.2 Site 7 Groundwater

Alternatives were formulated from the technologies and process options that passed the screening process. The three alternatives selected for detailed evaluation in the FS for Site 7 groundwater included Alternative GW2-1 (No Action), Alternative GW2-2 (Institutional Controls with Monitoring), and Alternative GW2-3 (Extraction and Off-Site Discharge). Alternative GW2-1 was evaluated for comparison purposes, and the other alternatives were evaluated because of site conditions and their ability to meet the RAOs for Site 7 groundwater.

<u>Alternative GW2-1: No Action</u>

Under this alternative, no activities other than mandatory five-year reviews would be conducted at this site. The No Action Alternative for groundwater is not expected to be fully protective of human health and the environment. In particular, even though site groundwater is classified as GB, indicating that it is not suitable for regular human consumption, it could potentially be used in the future as a potable water supply. Also, if groundwater is encountered and removed during construction projects, contaminated groundwater could be discharged to adjacent streams and potentially impact aquatic ecological receptors. However, this alternative will be retained to serve as a basis for evaluating other alternatives.

- Estimated Time for Design and Construction: NA
- Estimated Time for Operation: 30 years
- Estimated Capital Cost: $0
- Estimated O&M Costs (Present Worth): $89,600
- Estimated Total Present Worth: $89,600

<u>Alternative GW2-2: Institutional Controls with Monitoring</u>

This alternative was developed to protect human health and the environment by placing restrictions on extraction and use of groundwater at this site. Under this alternative, institutional controls would be implemented to prohibit the placement of groundwater extraction wells in or use of groundwater from this area. If groundwater is encountered and removed during construction projects (e.g., trench dewatering), the groundwater would have to be characterized and properly disposed.

The NSB-NLON IR Site Use Restrictions document would note the location and types of contamination observed at the site. Future commercial or residential land use would be permitted as long as institutional controls are maintained. In the event of property transfer and with confirmation that contaminated groundwater remains at the site, an environmental land use restriction pursuant to state law would be used to prohibit the use of groundwater. Compliance monitoring to determine whether there are any violations of institutional control restrictions would also occur.

New and existing monitoring wells would be used to monitor the natural degradation of VOC and SVOC contaminants. Monitoring would continue until contaminant concentrations have decreased below the PRGs and the resulting concentrations are shown to be protective of human health and the environment.

- Estimated Time for Design and Construction: 6 months
- Estimated Time for Operation: 30 years
- Estimated Capital Cost: $59,700
- Estimated O&M Costs (Present Worth): $244,100
- Estimated Total Present Worth: $303,800

<u>Alternative GW2-3: Extraction and Off-Site Discharge</u>

This alternative was developed to protect human health and the environment by extracting all contaminated groundwater (approximately 1,250,000 gallons) through one groundwater extraction well and discharging the water to the Groton publicly owned treatment works (POTW) for treatment. Based on the level of contamination found, pre-treatment of the water is not expected. However, if pre-treatment is necessary, filtration and granular activated carbon (GAC) adsorption could be considered. If implemented, the alternative would represent a clean closure for groundwater at the site with no long-term requirements.

Additional temporary and permanent monitoring wells would be installed to better define the extent of groundwater contamination and to monitor groundwater contaminant capture and cleanup. Collected data would be used to characterize groundwater for treatment needs, if any, and discharge requirements.

- Estimated Time including Design and Completion: 1.5 years
- Estimated Capital Cost: $1,018,600
- Estimated O&M Costs (Present Worth): $105,500
- Estimated Total Present Worth: $1,121,000

2.9.1.3 Sites 9 and 23 Groundwater

The two alternatives evaluated for Sites 9 and 23 groundwater included Alternative GW3-1 (No Action) and Alternative GW3-2 (Institutional Controls). Active groundwater remedial technologies were not evaluated because of the absence of a contaminant plume and other site conditions (generally low concentrations of contaminants, groundwater not classified as a suitable potable water source, and availability and use of a public water supply). Alternative GW3-1 was evaluated for comparison purposes and Alternative GW3-2 was evaluated because of site conditions and its ability to meet the RAOs.

Alternative GW3-1: No Action

Under this alternative, no activities other than mandatory five-year reviews would be conducted at this site. The No Action Alternative for groundwater is not expected to be fully protective of human health and the environment. In particular, even though site groundwater is classified as GB, indicating that it is not suitable for regular human consumption, it could potentially be used in the future as a potable water supply. Also, if groundwater is encountered and removed during construction projects, contaminated groundwater could be discharged to adjacent streams and potentially impact aquatic ecological receptors. However, this alternative will be retained to serve as a basis for evaluating the other alternative.

- Estimated Time for Design and Construction: NA
- Estimated Time for Operation: 30 years
- Estimated Capital Cost: $0
- Estimated O&M Costs (Present Worth): $89,600
- Estimated Total Present Worth: $89,600

Alternative GW3-2: Institutional Controls

This alternative was developed to protect human health and the environment by placing restrictions on extraction and use of groundwater at this site. Under this alternative, institutional controls would be implemented to prohibit the placement of groundwater extraction wells in or use of groundwater from this area. If groundwater is encountered and removed during construction projects (e.g., trench dewatering), the groundwater would have to be characterized and properly disposed.

The NSB-NLON IR Site Use Restrictions document would note the location and types of contamination observed at the site. Future commercial or residential land use would be permitted as long as institutional controls are maintained. In the event of property transfer and with confirmation that contaminated groundwater remains at the site, an environmental land use restriction pursuant to state law would be used to prohibit the use of groundwater. Compliance monitoring to determine whether there are any violations of institutional control restrictions would also occur.

- Estimated Time for Design and Construction: 6 months
- Estimated Time for Operation: 30 years
- Estimated Capital Cost: $10,295
- Estimated O&M Costs (Present Worth): $108,705

- Estimated Total Present Worth: $119,000

2.9.2 Common Elements and Distinguishing Features of Each Alternative

2.9.2.1 Sites 3 and 7 Groundwater

Alternatives GW1-1 and GW1-2 are similar in that neither of the alternatives would actively treat the contaminated groundwater. Ultimately, site contaminants would be expected to degrade through natural biological, chemical, and physical processes. For Alternative GW1-1, no action would be taken except mandatory five-year site reviews.

Both Alternatives GW1-1 and GW1-2 allow the contaminated groundwater to remain in place, but Alternative GW1-2 includes institutional controls to restrict extraction and use of groundwater, monitoring at predetermined intervals until contaminant concentrations have decreased to less than PRGs and the resulting concentrations are shown to be protective of human health and the environment, and periodic site reviews that would be conducted every 5 years. Alternative GW1-2 would address the exposure pathways and risk issues with Sites 3 and 7 groundwater but would not open the sites for unrestricted future use.

2.9.2.2 Site 7 Groundwater

Alternatives GW2-1 and GW2-2 are similar in that neither of the alternatives would actively treat the contaminated groundwater. Ultimately, site contaminants would be expected to degrade through natural biological, chemical, and physical processes. For Alternative GW2-1, no action would be taken except mandatory five-year site reviews.

Alternatives GW2-1 and GW2-2 allow the contaminated groundwater to remain in place, but Alternative GW2-2 includes institutional controls to restrict extraction and use of groundwater, monitoring at predetermined intervals until contaminant concentrations have decreased to less than PRGs and the resulting concentrations are shown to be protective of human health and the environment, and periodic site reviews that would be conducted every 5 years.

Alternatives GW2-2 and GW2-3 are similar in that they both address the exposure pathways. However, Alternative GW2-2 addresses the exposure pathways associated with Site 7 groundwater by controlling construction and development activities, and Alternative GW2-3 addresses the exposure pathways by removing the contaminated groundwater and sending it to a POTW for treatment. Both alternatives address the risk issues with Site 7 groundwater, but Alternative GW2-3 opens the site for unrestricted future use.

Alternative GW2-3 is the alternative that provides active remediation of Site 7 groundwater. Alternative GW2-2, a passive alternative that allows for natural degradation of site contaminants, includes periodic inspection of compliance with institutional controls and monitoring.

2.9.2.3 Sites 9 and 23 Groundwater

Alternatives GW3-1 and GW3-2 are similar in that neither of the alternatives would actively treat the contaminated groundwater. For Alternative GW3-1, no action would be taken except mandatory five-year site reviews. Both Alternatives GW3-1 and GW3-2 allow contaminated groundwater to remain in place, but Alternative GW3-2 includes institutional controls to restrict extraction and use of groundwater and periodic site reviews that would be conducted every 5 years. Alternative GW3-2 would address the exposure pathways and risk issues with Sites 9 and 23 groundwater but would not open the sites for unrestricted future use.

2.9.3 Expected Outcomes of Each Alternative

2.9.3.1 Sites 3 and 7

Under Alternatives GW1-1 (No Action) and GW1-2 (Institutional Controls with Monitoring), Sites 3 and 7 could not be released for unrestricted use. In the event that the sites were released for unrestricted use, Alternative GW1-1 would not be protective of human health for potential future receptors. Institutional controls would be implemented to restrict extraction and use of groundwater at Sites 3 and 7 under Alternative GW1-2 until the contaminants in groundwater naturally degrade to concentrations less than the selected PRGs and the resulting concentrations are shown to be protective of human health and the environment.

2.9.3.2 Site 7

Under Alternatives GW2-1 (No Action) and GW2-2 (Institutional Controls with Monitoring), Site 7 could not be released for unrestricted use. In the event that the site was released for unrestricted use, Alternative GW2-1 would not be protective of human health for potential future receptors. Institutional controls and monitoring would be implemented to restrict extraction and use of groundwater at Site 7 under Alternative GW2-2 until the contaminants in groundwater naturally degrade to concentrations less than the selected PRGs and the resulting concentrations are shown to be protective of human health and the environment.

After implementation of Alternative GW2-3 (Extraction and Off-Site Discharge), Site 7 would be released for unrestricted use. Under this alternative, human health and the environment would be protected because the contaminated groundwater would be extracted from the site, treated as necessary, and discharged.

2.9.3.3 Sites 9 and 23

Under Alternatives GW3-1 (No Action) and GW3-2 (Institutional Controls), Sites 9 and 23 could not be released for unrestricted use. In the event that the sites were released for unrestricted use, Alternative GW3-1 would not be protective of human health for potential future receptors. Institutional controls would be implemented to restrict extraction and use of groundwater at Sites 9 and 23 under Alternative GW3-2 until contaminants concentrations are shown to be protective of human health and the environment.

2.10 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

This section of the ROD summarizes the comparative analysis of alternatives presented in the detailed analysis sections of the two FS Reports. The major objective is to evaluate the relative performance of the alternatives with respect to the nine evaluation criteria so that the advantages and disadvantages of each are clearly understood. The first two evaluation criteria, Overall Protection of Human Health and the Environment and Compliance with ARARs are threshold criteria that must be satisfied by any remedial alternative chosen for the site. The primary balancing criteria are then considered to determine which alternative provides the best combination of attributes. The primary balancing criteria are as follows:

- Long-term effectiveness and permanence
- Reduction in toxicity, mobility, or volume through treatment
- Implementability
- Short-term effectiveness
- Cost

The alternatives are evaluated further against the following two modifying criteria:

- Acceptance by the state
- Acceptance by the community

2.10.1 <u>Overall Protection of Human Health and the Environment</u>

2.10.1.1 Sites 3 and 7

The No Action Alternative, GW1-1, would not be protective of human health or the environment. Under this alternative, without monitoring or institutional controls, contamination would remain at the site without adequate notification. Groundwater could potentially be used for human consumption in a future residential scenario (RAO A-2), could be extracted and discharged during construction activities (e.g. excavation dewatering), and/or could migrate without degradation to a local stream and impact ecological receptors (RAO A-3). Based on existing characterization, groundwater is not anticipated to represent a significant risk to current receptors (construction workers) through incidental contact (RAO A-1) or to ecological receptors through migration (RAO A-3).

Under Alternative GW1-2, Institutional Controls with Monitoring, potential future risks associated with groundwater would be addressed by restricting a future residential scenario (RAO A-1), providing requirements for groundwater that could be extracted and discharged during construction activities (e.g., excavation dewatering), and monitoring the migration and natural degradation of groundwater contaminants (RAO A-3). Based on existing characterization, groundwater is not anticipated to represent a significant risk to current receptors (construction workers) through incidental contact (RAO A-2) or to ecological receptors through migration (RAO A-3).

The groundwater is currently classified as GB, groundwater concentrations are relatively low and sporadic or the magnitude of PRG exceedances are minor, and the sites are under military control. As a result, the potential for significant impact to human health and the environment is low. In addition, public potable water is available and used in the area, and local groundwater resources are not normally considered for use. Also, the COCs in Sites 3 and 7 groundwater are organic and are subject to slow natural biological and chemical degradation. Without active cleanup, groundwater concentrations should decrease to less than PRGs, but several years to several decades may be required.

2.10.1.2 Site 7

The No Action Alternative, GW2-1, would not be protective of human health or the environment. Under this alternative, without monitoring or institutional controls, contamination would remain at the site without adequate notification. Groundwater could be used for human consumption in a future residential scenario (RAO B-2), could be extracted and discharged during construction activities (e.g., excavation dewatering), and/or could migrate without degradation to a local stream and impact ecological receptors (RAO B-3). Based on existing characterization, groundwater is not anticipated to represent a significant risk to current receptors (construction workers) through incidental contact (RAO B-1) or to ecological receptors through migration (RAO B-3).

Under Alternative GW2-2, Institutional Controls with Monitoring, potential future risks associated with groundwater would be addressed by restricting a future residential scenario (RAO B-1), providing requirements for groundwater that could be extracted and discharged during construction activities (e.g., excavation dewatering), and monitoring the migration and natural degradation of groundwater contaminants (RAO B-3). Based on existing characterization, groundwater is not anticipated to represent a significant risk to current receptors (construction workers) through incidental contact (RAO B-2) or to ecological receptors through migration (RAO B-3).

The groundwater is currently classified as GB, groundwater concentrations are relatively low level and sporadic or the magnitude of PRG exceedances are minor, and the site is under military control. As a result, the potential for significant impact to human health and the environment is low. In addition, public potable water is available and used in the area and local groundwater sources are not normally considered for use. Also, the COCs in Site 7 groundwater are organic and are subject to slow natural biological and chemical degradation. Without active cleanup, groundwater concentrations should decrease to less than PRGs, but several years to several decades may be required.

For Site 7, Alternative GW2-3 would protect human health and the environment by removing contaminated groundwater from the site, pre-treating the extracted water, if necessary, and discharging the water to the POTW for final treatment and discharge. Groundwater monitoring would be completed to monitor groundwater contaminant capture and cleanup. After removal of the contaminated groundwater from the site, there would be no remaining risks associated with Site 7 groundwater.

2.10.1.3 Sites 9 and 23

The No Action Alternative is not protective of human health or the environment. Under this alternative, without institutional controls, contamination would remain at the site without adequate notification. Groundwater could potentially be used for human consumption in a future residential scenario (RAO C-1), could be extracted and discharged during construction activities (e.g. excavation dewatering), and/or could migrate without degradation to a local stream and impact ecological receptors (RAO C-2). Based on existing characterization, groundwater is not anticipated to represent a significant risk to current receptors (construction workers) through incidental contact or to ecological receptors through migration.

Under Alternative GW3-2, Institutional Controls, potential future risks associated with groundwater would be addressed by restricting a future residential scenario (RAO C-1) and providing requirements for groundwater that could be extracted and discharged during construction activities (e.g., excavation dewatering). Based on existing characterization, groundwater is not anticipated to represent a significant risk to current receptors (construction workers) through incidental contact or to ecological receptors through migration.

The groundwater is currently classified as GB, groundwater concentrations are relatively low and sporadic, and the sites are under military control. As a result, the potential for significant impact to human health and the environment is low. In addition, public potable water is available and used in the area, and local groundwater resources are not normally considered for use.

2.10.2 Compliance with ARARs

Section 121(d) of CERCLA and the NCP, 40 CFR 300.430(f)(1)(ii)(B), require that RAs at CERCLA sites at least attain legally applicable or relevant and appropriate federal environmental rules, regulations, and criteria, and state environmental and facility siting statutes, regulations, and requirements, unless such ARARs are waived under CERCLA section 121(d)(4).

2.10.2.1 Sites 3 and 7

An assessment of ARARs and To Be Considereds (TBCs) for Alternative GW1-1 is provided in Table 2-21. The No Action Alternative would not comply with chemical-specific ARAR or TBCs. Considering TBCs, the No Action Alternative would result in unacceptable risks from exposure to contaminated groundwater. No restrictions on groundwater use would be implemented under the alternative, and future groundwater use could result in unacceptable risks to receptors. Location- and action-specific ARARs are not applicable to Alternative GW1-1.

An assessment of ARARs and TBCs for Alternative GW1-2 is provided in Tables 2-22, 2-23, and 2-24. This alternative would comply with all chemical-specific ARARs and TBCs. Institutional Controls would be established for the active base through the NSB-NLON IR Site Use Restriction document. If the Navy was to transfer ownership of the property, the institutional controls would be established through environmental land use restrictions, pursuant to state law, that would prevent use of contaminated groundwater. Monitoring of compliance with institutional controls would also be required.

Even though contaminants in site groundwater currently exceed groundwater quality standards (Class GA), site groundwater is classified as GB. GA groundwater quality should ultimately be obtained through natural degradation. Monitoring would be used to track this decrease until concentrations are less than acceptable levels. This alternative would meet chemical-specific TBCs by preventing exposure to contaminated groundwater until concentrations are below acceptable levels that meet human health concerns. This alternative would also comply with all action-specific ARARs. Monitoring would continue until concentrations are less than acceptable levels that meet human health concerns. Any waste (soil or groundwater) generated during the installation of monitoring wells or monitoring activities will be properly characterized and disposed. Because the sites are in a coastal zone management area, activities associated with this alternative would meet the substantive requirements of location-specific ARARs.

2.10.2.2 Site 7

An assessment of ARARs and TBCs for Alternative GW2-1 is provided in Table 2-21. The No Action Alternative would not comply with chemical-specific ARARs and TBCs. Considering TBCs, the No Action Alternative would result in unacceptable risks from exposure to contaminated groundwater. No restrictions on groundwater use would be implemented under the alternative, and future groundwater use could result in unacceptable risks to receptors. Location- and action-specific ARARs are not applicable to Alternative GW2-1.

An assessment of ARARs and TBCs for Alternative GW2-2 is provided in Tables 2-22, 2-23, and 2-24. This alternative should comply with all chemical-specific ARARs and TBCs. Institutional controls would be established for the active base through the NSB-NLON IR Site Use Restriction document. If the Navy was to transfer ownership of the property, the institutional controls would be established through environmental land use restrictions, pursuant to state law, that would prevent use of contaminated groundwater. Monitoring of compliance with institutional controls would also be required.

Even though contaminants in site groundwater currently exceed groundwater quality standards (Class GA), site groundwater is classified as GB. GA groundwater quality should ultimately be obtained through natural degradation. Monitoring would be used to track this decrease until concentrations are below acceptable levels. This alternative would meet chemical-specific TBCs by preventing exposure to contaminated groundwater until concentrations are below acceptable levels that meet human health concerns. This alternative would also comply with all action-specific ARARs. Monitoring would continue until concentrations are less than acceptable levels that meet human health concerns. Any waste (soil or groundwater) generated during the installation of monitoring wells or monitoring activities will be properly characterized and disposed. Because Site 7 is in a coastal zone management area, activities associated with this alternative would meet the requirements of location-specific ARARs.

An assessment of ARARs and TBCs for Alternative GW2-3 is provided in Tables 2-25, 2-26, and 2-27. This alternative would comply with all chemical-specific ARARs and TBCs. Site groundwater with contaminant concentrations that currently exceed groundwater quality standards (Class GA) would be removed and there would be no remaining unacceptable risks to human health. Monitoring would be used to track and confirm this cleanup.

Alternative GW2-3 would comply with action-specific ARARs associated with monitoring and the pre-treatment requirements with the Groton POTW. Monitoring would continue until concentrations are below acceptable levels that meet human health concerns. Any waste (soil or groundwater) generated during the installation of monitoring wells or monitoring activities would be properly characterized and disposed. If pre-treatment residues are generated (filter media and GAC), the off-site disposal of this residue would trigger federal and State solid waste regulations and based on characterization, could trigger hazardous waste regulations. During pre-treatment, these residues would be characterized for hazardous waste properties and recycling value and would be managed accordingly. Location-specific ARARs are not applicable to Alternative GW2-3.

2.10.2.3 Sites 9 and 23

An assessment of ARARs and TBCs for Alternative GW3-1 is provided in Table 2-21. The No Action Alternative would not comply with chemical-specific ARARs and TBCs. Considering TBCs, the No Action Alternative would result in unacceptable risks from exposure to contaminated groundwater. No restrictions on groundwater use would be implemented under the alternative, and future groundwater use could result in unacceptable risks to receptors. Location- and action-specific ARARs are not applicable to Alternative GW3-1.

An assessment of ARARs and TBCs for Alternative GW3-2 is provided in Tables 2-28 and 2-29. This alternative would comply with all chemical-specific ARARs and TBCs. Institutional controls would be established for the active base through the NSB-NLON IR Site Use Restriction document. If the Navy were to transfer ownership of the property, the institutional controls would be established through environmental land use restrictions, pursuant to state law, that would prevent use of contaminated groundwater. Monitoring of compliance with institutional controls would also be required. Even though contaminants in site groundwater currently exceed groundwater quality standards (Class GA), site groundwater is classified as GB. This alternative would meet chemical-specific ARARs and TBCs and action-specific ARARs by preventing exposure to contaminated groundwater until concentrations are less than acceptable levels. Location-specific ARARs are not applicable to Alternative GW3-2.

2.10.3 <u>Long-Term Effectiveness and Permanence</u>

2.10.3.1 Sites 3 and 7

There is an estimated 24,700,000 gallons of contaminated groundwater present at Sites 3 and 7, based on data from the BGOURI Update/FS. VC was detected at a maximum concentration of 31.5 µg/L during the BGOURI sampling events (2000 and 2002), and the corresponding PRG for VC is 1.6 µg/L. TCE (23 µg/L) and HCB (3 µg/L) were also detected during the BGOURI in site groundwater at concentrations greater than their respective PRGs (5 and 1 µg/L, respectively). Groundwater monitoring was initiated in 2006 at the sites, and the Year 1 results, which are discussed in Section 2.5.2.2, have shown that contaminant concentrations are generally decreasing and nearing the PRGs. These results suggest that a limited action alternative (e.g., institutional controls and monitoring) will be an effective and permanent remedy for the sites.

Alternative GW1-1 may not be effective in the long term. Groundwater contaminants could remain at the site for extended periods of time. Groundwater use, handling, and/or discharge would not be restricted. Ultimately, the site contaminants would be expected to degrade through natural biological, chemical, and physical processes. However, the duration and magnitude of contamination would not be monitored, and the residual risks would not be known.

Alternative GW1-2 is expected to be relatively effective in the long term and will ultimately be permanent. The presence of both federal (NSB-NLON institutional controls) and state (groundwater classifications) controls should effectively prevent the use and exposure to contaminated groundwater. Potential migration and degradation of contaminated groundwater would be monitored and the results would be used to identify the need for additional action. Ultimately, it is expected that improvements in groundwater quality would occur, but it would depend on relatively slow natural biological, chemical, and physical processes. The magnitude of residual contamination would be monitored over time, and potential risks associated with the contamination could be quantified.

2.10.3.2 Site 7

At Site 7 alone, there is estimated to be 170,000 gallons of contaminated groundwater, based on data from the BGOURI Update/FS. CB was detected in groundwater at a maximum concentration of 165 µg/L, and the corresponding PRG for CB is 100 µg/L. DCB (90.5 µg/L) and benzene (2 µg/L) were also detected at the site at concentrations greater than PRGs (75 and 1 µg/L, respectively) during the BGOURI. Groundwater monitoring was initiated at Site 7 in 2006, and the results, which are discussed in Section 2.5.2.3, have shown that contaminant concentrations have generally decreased to less than the PRGs. These results suggest that a limited action alternative (e.g., institutional controls and monitoring) will be an effective and permanent remedy for the site.

Alternative GW2-1 may not be effective in the long term. Groundwater contaminants could remain at the site for extended periods of time. Groundwater use, handling, and/or discharge would not be restricted. Ultimately, the site contaminants would be expected to degrade through natural biological, chemical, and physical processes. However, the duration and magnitude of contamination would not be monitored, and the residual risks would not be known

Alternative GW2-2 is expected to be relatively effective in the long term and will ultimately be permanent. The presence of both federal (NSB-NLON institutional controls) and state (groundwater classifications) controls should effectively prevent the use of contaminated groundwater as a potable water supply. Potential migration and degradation of contaminated groundwater would be monitored, and the results would be used to identify the need for additional action. Ultimately, the site contaminants would be expected to degrade through natural biological, chemical, and physical processes. The magnitude of residual contamination would be monitored over time, and potential risks associated with the contamination could be quantified.

It is estimated that 1,250,000 gallons of groundwater need to be extracted to remove the 170,000 gallons of contaminated groundwater. By removing and treating the Site 7 contaminated groundwater, Alternative GW2-3 would be very effective and permanent. Future monitoring or other actions would not be required. In the unlikely event that a continuing source of contaminants is present, then recontamination of the groundwater could occur.

2.10.3.3 Sites 9 and 23

Alternative GW3-1 may not be effective in the long term. Groundwater contaminants could remain at the site for extended periods of time. Groundwater use, handling, and/or discharge would not be restricted. Alternative GW3-2 is expected to be relatively effective in the long term and will ultimately be permanent. The presence of both federal (NSB-NLON institutional controls) and state (groundwater classifications) controls should effectively prevent the use and exposure to contaminated groundwater.

2.10.4 Reduction of Toxicity, Mobility, or Volume through Treatment

2.10.4.1 Sites 3 and 7

Alternatives GW1-1 and GW1-2 do not use active treatment of site contaminants; therefore, this criterion is not applicable.

2.10.4.2 Site 7

Alternatives GW2-1 and GW2-2 do not use active treatment of site contaminants; therefore, this criterion is not applicable.

Alternative GW2-3 uses pre-treatment at the site or treatment at the POTW to remove and ultimately destroy more than 0.36 pound of VOCs. The ultimate fate of the organics would depend on pre-treatment requirements. If pre-treatment is used, the organics would adsorb onto GAC. During off-site regeneration of the GAC, the organics would be thermally oxidized into mineral compounds. If the organics are treated in the POTW, they would be subject to biological degradation, volatilization (and photochemical destruction), and adsorption onto sludge for ultimate disposal in a landfill.

2.10.4.3 Sites 9 and 23

Alternatives GW3-1 and GW3-2 do not use active treatment of site contaminants; therefore, this criterion is not applicable.

2.10.5 <u>Short-Term Effectiveness</u>

2.10.5.1 Sites 3 and 7

Both groundwater alternatives are expected to be effective in the short term. The groundwater is currently classified as GB, and the contamination is sporadically distributed across Sites 3 and 7. Groundwater is not used for human consumption, and public potable water is available and used.

There would not be any short-term risks to the community, workers, or environment under Alternative GW1-1 because no active RA would be taken. Alternative GW1-2 remedial actions, including well installation and monitoring, along with implementation of institutional controls, would pose no short-term risk as long as proper worker safety precautions were made when handling potentially contaminated soil and groundwater during well installation and monitoring.

Alternative GW1-1 would not achieve the RAOs. Alternative GW1-2 would achieve the RAOs within approximately 6 months, the time required to implement institutional controls and start monitoring. Under both alternatives, final degradation of site groundwater contamination is expected to require years to decades to complete.

2.10.5.2 Site 7

All three groundwater alternatives are expected to be effective in the short term. The groundwater is currently classified as GB at Site 7. Groundwater is not used for human consumption, and public potable water is available and used.

There would not be any short-term risks to the community, workers, or environment under any of the three alternatives. Under Alternatives GW2-2 and GW2-3, no short-term risks would result as long as proper worker safety precautions were taken during implementation of the alternatives.

Alternative GW2-1 would not achieve the RAOs. Alternative GW2-2 would achieve the RAOs within approximately 6 months, the time required to implement institutional controls and start monitoring. Under both alternatives, final degradation of site groundwater contamination is expected to require years to decades to complete. Alternative GW2-3 can be completed within 1.5 years after the start of design activities. RAOs would be achieved at that time.

2.10.5.3 Sites 9 and 23

Both groundwater alternatives are expected to be effective in the short term. The groundwater is currently classified as GB, groundwater is not used for human consumption, and public potable water is available and used. There would not be any short-term risks to the community, workers, or environment under Alternative GW3-1 because no active RA would be taken. Implementation of institutional controls under Alternative GW3-2 would pose no short-term risk as long as proper worker safety precautions were taken when site inspections are performed.

2.10.6 Implementability

2.10.6.1 Sites 3 and 7

Alternatives GW1-1 and GW1-2 would be easy to implement. All the necessary documents for Alternatives GW1-2 (groundwater monitoring plan, institutional controls, etc.) can be handled internally by the Navy. Vendors and equipment to perform groundwater monitoring are common and readily available.

2.10.6.2 Site 7

Because no active RA is occurring, Alternatives GW2-1 and GW2-2 would be easy to implement. All the necessary documents for Alternatives GW2-2 (groundwater monitoring plan, institutional controls, etc.) can be handled internally by the Navy. Vendors and equipment to perform groundwater monitoring are common and readily available.

Alternative GW2-3 should be readily implementable. Vendors and equipment to perform this work are common and readily available. POTW facility capacity is also adequate.

2.10.6.3 Sites 9 and 23

Alternatives GW3-1 and GW3-2 would be easy to implement. All the necessary documents for Alternatives GW3-2 associated with institutional controls can be handled internally by the Navy.

2.10.7 Cost

The estimated costs for the alternatives are presented below. It should be noted that for the alternatives evaluated, capital costs and annual O&M costs were calculated using present dollars, and do not account for inflation or the future value of money when calculating annual costs.

Alternative	Capital Cost	O&M Cost (Present Worth)	Total Cost (Present Worth)
Sites 3 and 7			
Alternative GW1-1	$0	$89,600	$89,600
Alternative GW1-2	$59,200	$260,300	$319,500
Site 7			
Alternative GW2-1	$0	$89,600	$89,600
Alternative GW2-2	$59,700	$244,100	$303,800
Alternative GW2-3	$1,018,600	$105,500	$1,121,000
Sites 9 and 23			
Alternative GW3-1	$0	$89,600	$89,600
Alternative GW3-2	$10,295	$108,705	$119,000

2.10.8 State Acceptance

The State of Connecticut has expressed their support with the Selected Remedy (described in Section 2.12). The state's concurrence letter is provided in Appendix A.

2.10.9 Community Acceptance

Based on comments expressed at the Public Meeting on June 26, 2008 and the written comments received during the public comment period, it appears that the community generally agrees with the Selected Remedy presented in the Proposed Plan. Specific responses to issues raised by the community can be found in the Responsiveness Summary in Section 3.0 of this ROD.

2.11 PRINCIPAL THREAT WASTE

The NCP establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable [40 CFR 300.430(a)(1)(iii)(A)]. Based on the results of the investigations and studies, the contaminants in the groundwater at Sites 2, 3, 7, 9, 14, 15, 18, 20, and 23 do not constitute principal threat wastes as defined by the NCP.

2.12 SELECTED REMEDY

This section identifies the Selected Remedy and expands on the details provided in Section 2.9 (Description of Alternatives) of the ROD.

2.12.1 Sites 3 and 7

The Selected Remedy for Sites 3 and 7 groundwater is to combine Alternatives GW1-2 and GW2-2, Institutional Controls and Monitoring. The Selected Remedy was first documented in the 2004 Interim ROD and has not changed in this Final ROD. The Selected Remedy meets all of the RAOs by restricting access to and use of contaminated groundwater and by monitoring the decay and potential migration of contaminated groundwater at the sites. The Selected Remedy consists of three major components: (1) implementation and long-term monitoring of LUCs at the sites, (2) conducting a comprehensive monitoring program to track the degradation and decay of site contaminants until they reach RGs and the resulting concentrations are shown to be protective of human health and the environment, and to verify that groundwater contaminants are not migrating and impacting other resources, and (3) completion of five-year reviews of the site until the RGs are reached. The RGs for the Selected Remedy are provided in Tables 2-19 and 2-20. The components of the remedy are discussed in more detail below.

2.12.1.1 Institutional Controls

Based on the Interim ROD for groundwater at Sites 3, 7, 14, 15, 18, and 20 (Navy, 2004e), the Navy prepared a LUC Remedial Design (RD) to implement LUCs for Sites 3 and 7 groundwater (Navy, 2005). In accordance with this approved LUC RD, the Navy is responsible for implementing, inspecting, reporting on, and maintaining the institutional controls described in the ROD when the base is active through the NSB-NLON IR Site Use Restrictions document, and if the property is transferred to civilian ownership, through property transfer documents that include environmental land use restrictions. Should any institutional control component of the selected remedy fail, the Navy will ensure that appropriate actions are taken to re-establish the Selected Remedy's protectiveness. The Navy may transfer various operational responsibilities for these actions to other parties through contracts, agreements, and/or deed restrictions. However, the Navy acknowledges its ultimate liability under CERCLA for remedy integrity, including for the performance of any transferred operational responsibilities.

The groundwater institutional controls are required because there are hazardous substances in groundwater at Sites 3 and 7 at concentrations that could result in unacceptable risks if groundwater use was not controlled or restricted. The objectives of the institutional controls for the Selected Remedy are as follows:

- Prevent the withdrawal and/or use of groundwater from Sites 3 and 7 for potable water purposes or other purposes that may result in unacceptable risks to human health and the environment until the RGs identified in this ROD are met.

- Ensure that groundwater extracted from Sites 3 and 7 during groundwater monitoring or construction dewatering activities is handled, stored, and disposed in accordance with applicable state and federal regulatory requirements.

- Maintain the integrity of the proposed groundwater monitoring system for Sites 3 and 7 until the RGs identified in this ROD are met.

Figure 2-21 identifies the areas at NSB-NLON that have groundwater LUCs. The controls on groundwater use at Sites 3 and 7 will be maintained until the results of the groundwater monitoring program show that the concentrations of hazardous substances in groundwater are less than the RGs that allow for unrestricted use and unlimited exposure.

NSB-NLON Installation Restoration Site Use Restrictions Instruction document (5090.18B), dated February 5, 2003, was updated in accordance with the Interim ROD to include groundwater use restrictions at Sites 3 and 7. An updated document, SOPA (ADMIN) New London Instruction 5090.18C was issued on December 14, 2006. The current SOPA (ADMIN) New London Instruction 5090.18D is included in Appendix B. Other LUC implementation actions completed or to be completed are described in the LUC RD (Navy, 2005). Based on the results of the 2008 vapor intrusion evaluation, the institutional controls for Site 3 will be amended to state that additional evaluation or installation of mitigative measures relating to vapor intrusion will be implemented if future residential construction takes place within 100 feet of well 2DMW29S.

NSB-NLON is currently an active Navy base and is expected to remain so into the foreseeable future. Potential future land uses for Sites 3 and 7 while the Navy owns the property include the continued use of the sites under their current Naval functions (i.e., industrial and recreational). Future land uses are limited because portions of Sites 3 and 7 are located within designated ESQD arcs of Site 20. Navy regulations prohibit construction of inhabited buildings or structures within these arcs and, although existing buildings operate under a waiver of these regulations, no further construction or residential development is planned for these sites. In addition, the groundwater aquifers found within the overburden and bedrock at Sites 3 and 7 are classified as GB by the State of Connecticut. Based on the GB classification, the groundwater is presumed not suitable for human consumption without treatment. Neither aquifer is currently used as a source of drinking water or for industrial water supply purposes, and there are no plans to use either aquifer in the future for these purposes. The institutional controls for groundwater implemented for Sites 3 and 7 place further restrictions on the extraction and use of groundwater at these sites until the groundwater RGs are reached. In the event that the Navy sells or transfers the property in the future, and with confirmation that contaminated groundwater remains at Sites 3 and/or 7, an environmental land use restriction pursuant to state law would be needed to prohibit the use of groundwater at the sites during subsequent site ownership. Future commercial or residential land use would be permitted as long as controls on groundwater extraction and use were maintained. In accordance with the Navy's responsibilities under CERCLA and the FFA, the administrative implementability of institutional controls would require including adequate provisions in any property transfer documents to ensure continuation of these controls should the Navy sell or transfer the property.

2.12.1.2 Monitoring

Groundwater monitoring has been conducted at Sites 3 and 7 since May 2006 in accordance with the Interim ROD and Sites 3 and 7 Groundwater Monitoring Plan (GMP) included in the O&M Manual For IR Program Sites (TtNUS, 2006a). After signing of the Interim ROD, a Work Plan for Remedial Action at Sites 3 and 7 (TtNUS, 2006b) was submitted describing the field activities required to complete the monitoring well network and the requirements for sampling and analysis. Prior to the start of monitoring, eight new wells were installed and developed, including three overburden wells at Site 3, one bedrock well at Site 3, and four overburden wells at Site 7, and the nine existing wells to be sampled as part of the monitoring program (five wells at Site 3 and four at Site 7) were redeveloped. Year 1 monitoring results for Sites 3 and 7 are presented in Tables 2-1 and 2-2, respectively.

The nine wells at Site 3 and seven of the eight wells at site 7 are analyzed for VOCs. Six wells at Site 7 are also analyzed for SVOCs, and one well at Site 7 is analyzed for PAHs only. The PAH data are used to evaluate the effectiveness of the Site 7 soil remediation; PAHs are not groundwater COCs at Site 7 and do not have associated groundwater RGs. The results are used to confirm that PAHs in the source area did not migrate and impact underlying groundwater.

The Interim ROD stated that monitoring would be conducted quarterly for the first year, annually for the next 4 years, and then every 5 years thereafter until contaminant concentrations have decreased to less than RGs for three consecutive sampling events and the resulting concentrations are shown to be protective of human health and the environment, or until the remedy is otherwise deemed protective or modified. However, based on the results of Year 1 sampling, continued quarterly sampling of Sites 3 and 7 for Year 2 was recommended (TtNUS, 2007). At the completion of the RA, the RGs will be met in groundwater at each of the monitoring wells included in the monitoring well network. A risk assessment following the most recent methodology may need to be completed to show that the resulting concentrations are protective of human health.

The COCs at Sites 3 and 7 are subject to natural degradation processes including biological, chemical, and physical processes. The magnitude and extent of this contamination are expected to decrease naturally overtime, and monitoring results will be used to track these decreases.

If subsurface activities are conducted and groundwater is to be encountered, construction workers must wear appropriate personnel protective equipment (PPE). If contaminated groundwater is to be removed, it must be tested, handled, and disposed properly (e.g., at a POTW or off-site treatment facility and not discharged to an adjacent stream without treatment).

2.12.1.3 Five-Year Reviews

Five-year reviews will be conducted for Sites 3 and 7 groundwater as required under CERCLA until the monitoring program shows that the RGs have been reached and the resulting concentrations are shown to be protective of human health and the environment. The goal of conducting the site reviews is to verify that no changes have occurred that would impact the effectiveness of the Selected Remedy.

2.12.2 Sites 9 and 23

The Selected Remedy for Sites 9 and 23 groundwater is Alternative GW3-2, Institutional Controls. The Selected Remedy meets all of the RAOs by restricting access to and use of contaminated groundwater and consists of two major components: (1) implementation of LUCs at the sites and (3) completion of five-year reviews. The components of the remedy are discussed in more detail below.

2.12.2.1 Institutional Controls

Implementation of institutional controls at Sites 9 and 23 involves identifying the location, magnitude, and type of contamination and documenting it in a LUC RD and in the NSB-NLON IR Site Use Restrictions document. These documents present the LUC objectives and include specific drawings and instructions for Navy personnel so that contaminated groundwater will not be extracted or used in a manner that would threaten human health or the environment. In accordance with the LUC RD to be prepared for Site 9 and 23, the Navy will be responsible for implementing, inspecting, reporting on, and maintaining the institutional controls described in the ROD. Should any institutional control component of the selected remedy fail, the Navy will ensure that appropriate actions are taken to re-establish the Selected Remedy’s protectiveness. The Navy may transfer various operational responsibilities for these actions to other parties through contracts, agreements, and/or deed restrictions. However, the Navy acknowledges its ultimate liability under CERCLA for remedy integrity, including for the performance of any transferred operational responsibilities.

The groundwater institutional controls are required because there are hazardous substances in groundwater at Sites 9 and 23 at concentrations that could result in unacceptable risks if groundwater use was not controlled or restricted. The objectives of the institutional controls for the Selected Remedy are as follows:

- Prevent the withdrawal and/or use of groundwater from Sites 9 and 23 for potable water purposes or other purposes that may result in unacceptable risks to human health and the environment.

- Ensure that groundwater extracted from Sites 9 and 23 during construction dewatering activities is handled, stored, and disposed in accordance with applicable state and federal regulatory requirements.

Figure 2-21 identifies the areas at NSB-NLON that have groundwater LUCs. The controls on groundwater use at Sites 9 and 23 will be maintained until the concentrations of hazardous substances in groundwater are less than levels that allow for unrestricted use and unlimited exposure.

NSB-NLON Installation Restoration Site Use Restrictions Instruction document (5090.18D) (Appendix B) has been updated in accordance with this ROD to include groundwater use restrictions at Sites 9 and 23. Other LUC implementation actions completed or to be completed will be described in the LUC RD to be issued by the Navy.

NSB-NLON is currently an active Navy base and is expected to remain so into the foreseeable future. Potential future land uses for Sites 9 and 23 while the Navy owns the property include the continued use of the sites under their current Naval functions (i.e., industrial and recreational). The groundwater at Sites 9 and 23 are classified as GB by the State of Connecticut. Based on the GB classification, the groundwater is presumed not suitable for human consumption without treatment and is not currently used as a source of drinking water or for industrial water supply purposes, and there are no plans to use it in the future for these purposes. The institutional controls for groundwater implemented for Sites 9 and 23 place further restrictions on the extraction and use of groundwater at these sites. In the event that the Navy sells or transfers the property in the future, and with confirmation that contaminated groundwater remains at Sites 9 and/or 23, an environmental land use restriction pursuant to state law would be needed to prohibit the use of groundwater at the sites during subsequent site ownership. Future commercial or residential land use would be permitted as long as controls on groundwater extraction and use were maintained.

2.12.2.2 Five-Year Reviews

Five-year reviews will be conducted for Sites 9 and 23 groundwater as required under CERCLA until contaminant concentrations are shown to be protective of human health and the environment. The goal of conducting the site reviews is to verify that no changes have occurred that would impact the effectiveness of the Selected Remedy.

2.12.3 Sites 2A, 2B, 14, 15, 18, and 20

This ROD selects NFA for groundwater at Sites 14, 15, 18, and 20. Available information indicates that groundwater at these sites does not pose any unacceptable risks to human health or the environment. Groundwater monitoring at Sites 2A and 2B will continue as required by the OU1 ROD and the O&M Manual for IR Program Sites (TtNUS, 2006a). This ROD proposes no change to the OU1 ROD.

2.13 STATUTORY DETERMINATIONS

Under CERCLA Section 121 and the NCP, the lead agency (i.e., Navy) must select remedies that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practical. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of contamination as a principal element and a bias against off-site disposal of untreated wastes.

The following sections discuss how the Selected Remedy for Sites 3 and 7 and Sites 9 and 23 groundwater meet these statutory requirements. Because NFA was selected for groundwater at Sites 14, 15, 18, and 20, an evaluation of statutory requirements for these sites is not necessary.

2.13.1 Protection of Human Health and the Environment

2.13.1.1 Sites 3 and 7

The Selected Remedy for groundwater at Sites 3 and 7 (Institutional Controls with Monitoring, Alternatives GW1-2 and GW2-2) addresses potential future risks and provides adequate protection of human health and the environment. Potential future risks are addressed by restricting future residential use (RAOs A-1 and B-1), providing requirements for groundwater that could be extracted and discharged during construction activities (e.g., excavation dewatering), and monitoring the migration and natural degradation of groundwater contaminants (RAOs A-3 and B-3). Based on existing data and evaluations, groundwater is not anticipated to represent a significant risk to current receptors (construction workers) through incidental contact (RAOs A-2 and B-2) or to ecological receptors through migration (RAOs A-3 and B-3).

2.13.1.2 Sites 9 and 23

The Selected Remedy for groundwater at Sites 9 and 23 (Institutional Controls, Alternative GW3-2) addresses potential future risks and provides adequate protection of human health and the environment.

Potential future risks are addressed by restricting future residential use (RAO C-1) and providing requirements for groundwater that could be extracted and discharged during construction activities (e.g., excavation dewatering). Based on existing data and evaluations, groundwater is not anticipated to represent a significant risk to current receptors (construction workers) through incidental contact or to ecological receptors through migration (RAO C-2).

2.13.2 Compliance with ARARs

2.13.2.1 Sites 3 and 7

An assessment of ARARs and TBCs for the Sites 3 and 7 Selected Remedy is provided in Tables 2-22, 2-23, and 2-24. The remedy will comply with all chemical-specific ARARs and TBCs. Chemical-specific ARARs include the RSRs; these Connecticut regulations provide specific numerical cleanup criteria for contaminants in groundwater. Requirements are based on groundwater in the area being classified by the state as GB. Institutional controls or environmental land use restrictions pursuant to state law (if the Navy sells the property in the future) will be implemented to prevent contact with and use of contaminated groundwater. Even though contaminants in site groundwater currently exceed groundwater quality standards (Class GA), site groundwater is classified as GB. GA groundwater quality should ultimately be obtained through natural degradation. Monitoring would be used to track these decreases until concentrations are less than acceptable levels. The remedy would meet chemical-specific TBCs by preventing exposure to contaminated groundwater until concentrations are less than acceptable levels that meet human health concerns.

The Selected Remedy also complies with all action-specific ARARs. Monitoring would continue until concentrations are less than acceptable levels that meet human health concerns. Any waste (soil or groundwater) generated monitoring activities will be properly characterized and disposed. Location-specific ARARs are not applicable to the Selected Remedy.

2.13.2.2 Sites 9 and 23

An assessment of ARARs and TBCs for the Sites 9 and 23 Selected Remedy is provided in Tables 2-28 and 2-29. The remedy will comply with all chemical-specific ARARs and TBCs. Chemical-specific ARARs include the RSRs; these Connecticut regulations provide specific numerical cleanup criteria for contaminants in groundwater. Requirements are based on groundwater in the area being classified by the state as GB. Institutional controls or environmental land use restrictions (if the Navy sells the property in the future) will be implemented to prevent contact with and use of contaminated groundwater. Even though contaminants in site groundwater currently exceed groundwater quality standards (Class GA), site groundwater is classified as GB. The remedy would meet chemical-specific TBCs by preventing exposure to contaminated groundwater until concentrations are less than acceptable levels that meet human health concerns.

The Selected Remedy also complies with all action-specific ARARs. Monitoring would continue until concentrations are less than acceptable levels that meet human health concerns. Location-specific ARARs are not applicable to the Selected Remedy.

2.13.3 Cost Effectiveness

2.13.3.1 Sites 3 and 7

The Selected Remedy for Sites 3 and 7 is considered to be the most cost-effective alternative. The lower cost No Action alternatives (GW1-1 and 2-1) would not satisfy the threshold criteria or RAOs, and Extraction and Off-Site Discharge (Alternative GW2-3) would cost over $1 million and only address Site 7 groundwater contaminants.

The cost for the Selected Remedy is estimated to be the sum of the costs for Alternatives GW1-2 ($319,500) and GW2-2 ($303,800), or $623,300. Although some economy may be realized when combining the alternatives, any savings are expected to be within the accuracy range of an FS level cost estimate (e.g., -30 to +50 percent); therefore, no attempt was made to further refine this cost. The present worth cost analysis for the Selected Remedy is presented in Appendix G and summarized as follows:

- Estimated Time for Design and Construction: 6 months
- Estimated Time for Operation: 30 years
- Estimated Capital Cost: $118,900
- Estimated O&M Costs (Present Worth): $504,400
- Estimated Total Present Worth: $623,300

2.13.3.2 Sites 9 and 23

The Selected Remedy for Sites 9 and 23 is considered to be the most cost-effective alternative. The lower cost No Action alternative (GW3-1) would not satisfy the threshold criteria or RAOs. The present worth cost analysis for the Selected Remedy is presented in Appendix G and summarized as follows:

- Estimated Time for Design and Construction: 6 months
- Estimated Time for Operation: 30 years
- Estimated Capital Cost: $10,295

- Estimated O&M Costs (Present Worth): $108,705
- Estimated Total Present Worth: $119,000

2.13.4 Utilization of Permanent Solutions and Alternative Treatment

The Navy, with EPA and state concurrence, has determined that the Selected Remedies represent the maximum extent to which permanent solutions and treatment technologies can be utilized in a practical manner for the groundwater at Sites 3 and 7 and Sites 9 and 23. Of those alternatives that are protective of human health and the environment and comply with ARARs, the Navy has determined that the Selected Remedies provide the best balance of trade-offs in terms of the five balancing criteria.

The Navy also considered the statutory preference for treatment as a principal element, the bias against off-site treatment and disposal, and EPA, state, and community acceptance. In-situ and above-ground treatment technologies for groundwater were screened for Sites 3 and 7 in the technology screening section of the FSs, but based on concerns about effectiveness because of relatively low contaminant concentrations and the sporadic distribution of contamination, coupled with anticipated high costs, these technologies were not retained for development of alternatives. Active remedial technologies were not evaluated for Sites 9 and 23 because of the absence of a contaminant plume and other sites conditions including generally low concentrations of contaminants, groundwater not classified as a suitable potable water source, and availability and use of a public water supply.

2.13.5 Preference for Treatment as a Principal Element

The Selected Remedies do not satisfy the statutory preference for treatment as a principal element. The reasons why treatment of Sites 3 and 7 and Sites 9 and 23 groundwater is not practical are discussed in Section 2.13.4.

2.13.6 Five-Year Review Requirements

Because the Selected Remedy for groundwater at Sites 3 and 7 will result in hazardous substances, pollutants, or contaminants remaining on site in excess of levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of the RA for Sites 3 and 7 groundwater, every 5 years until RGs are met, to ensure that the remedy is, or will be, protective of human health and the environment. Also, because the Selected Remedy for groundwater at Sites 9 and 23 will result in hazardous substances, pollutants, or contaminants remaining on site in excess of levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of the RA and every 5 years thereafter to ensure that the remedy is, or will be, protective of human health and the environment. Five-year reviews are not required under

OU9 for Sites 14, 15, 18, or 20 because hazardous substances, pollutants, or contaminants are not present on site in excess of levels that allow for unlimited use and unrestricted exposure. Five-year reviews of the OU1 remedy will continue for Sites 2A and 2B based on the OU1 ROD (Navy, 1995).

2.14 DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan for Sites 2A, 2B, 3, 7, 9, 14, 15, 18, 20, and 23 groundwater at NSB-NLON, Groton, Connecticut was released for public comment on June 14, 2008. The Proposed Plan identified Institutional Controls with Monitoring (Alternatives GW1-2 and GW2-2) as the Selected Remedy for Sites 3 and 7 groundwater and Institutional Controls (Alternative GW3-2) as the Selected Remedy for Sites 9 and 23 groundwater. NFA was recommended for Sites 14, 15, 18, and 20 groundwater in the Proposed Plan. Available information indicates that the groundwater at Sites 2, 14, 15, 18, and 20 do not pose any significant risks to human health or the environment. Groundwater monitoring and institutional controls will continue at Sites 2A and 2B as part of the OU1 remedy.

The Navy reviewed all written and verbal comments submitted during the public comment period. It was determined that no significant changes to these decisions, as originally identified in the Proposed Plan, were necessary or appropriate.

TABLE 2-1

YEAR 1 GROUNDWATER MONITORING RESULTS FOR SITE 3
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
PAGE 1 OF 3

CHEMICAL OF CONCERN	REMEDIAL GOAL	2DMW16D			
		May-06	Oct-06	Jan-07	Mar-07
VOLATILE ORGANIC COMPOUNDS (µg/L)					
TRICHLOROETHENE	5	**5.7**	**7**	**7**	**7**
VINYL CHLORIDE	2	0.5 U	1 U	1 U	1 U

CHEMICAL OF CONCERN	REMEDIAL GOAL	2DMW16S				
					Mar-07	
		May-06	Oct-06	Jan-07	Sample	Duplicate
VOLATILE ORGANIC COMPOUNDS (µg/L)						
TRICHLOROETHENE	5	0.5 U	1 U	1 U	1 U	1 U
VINYL CHLORIDE	2	0.5 U	1 U	1 U	1 U	1 U

CHEMICAL OF CONCERN	REMEDIAL GOAL	2DMW25S					
		May-06		Oct-06	Jan-07		Mar-07
		Sample	Duplicate		Sample	Duplicate	
VOLATILE ORGANIC COMPOUNDS (µg/L)							
TRICHLOROETHENE	5	0.5 U	0.5 U	1 U	1 U	1 U	1 U
VINYL CHLORIDE	2	0.5 U	0.5 U	1 U	1 U	1 U	1 U

CHEMICAL OF CONCERN	REMEDIAL GOAL	2DMW28D			
		May-06	Oct-06	Jan-07	Mar-07
VOLATILE ORGANIC COMPOUNDS (µg/L)					
TRICHLOROETHENE	5	0.5 U	1 U	1 U	1 U
VINYL CHLORIDE	2	0.5 U	1 U	1 U	1 U

YEAR 1 GROUNDWATER MONITORING RESULTS FOR SITE 3
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

CHEMICAL OF CONCERN	REMEDIAL GOAL	2DMW29S				
		May-06	Oct-06		Jan-07	Mar-07
			Sample	Duplicate		
VOLATILE ORGANIC COMPOUNDS (µg/L)						
TRICHLOROETHENE	5	0.5 U	1 U	1 U	1 U	1 U
VINYL CHLORIDE	2	1.7	9	10	1 U	4

CHEMICAL OF CONCERN	REMEDIAL GOAL	3MW15I			
		May-06	Oct-06	Jan-07	Mar-07
VOLATILE ORGANIC COMPOUNDS (µg/L)					
TRICHLOROETHENE	5	0.5 U	1 U	1 U	1 U
VINYL CHLORIDE	2	0.5 U	1 U	1 U	1 U

CHEMICAL OF CONCERN	REMEDIAL GOAL	3MW15S				
		May-06		Oct-06	Jan-07	Mar-07
		Sample	Duplicate			
VOLATILE ORGANIC COMPOUNDS (µg/L)						
TRICHLOROETHENE	5	0.5 U	0.5 U	1 U	1 U	1 U
VINYL CHLORIDE	2	0.5 U	0.5 U	1 U	1 U	1 U

CHEMICAL OF CONCERN	REMEDIAL GOAL	3MW16D			
		May-06	Oct-06	Jan-07	Mar-07
VOLATILE ORGANIC COMPOUNDS (µg/L)					
TRICHLOROETHENE	5	5.1	2	2	4
VINYL CHLORIDE	2	0.5 U	1 U	1 U	1 U

TABLE 2-1

YEAR 1 GROUNDWATER MONITORING RESULTS FOR SITE 3
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

CHEMICAL OF CONCERN	REMEDIAL GOAL	3MW16S			
		May-06	Oct-06	Jan-07	Mar-07
VOLATILE ORGANIC COMPOUNDS (µg/L)					
TRICHLOROETHENE	5	0.5 U	1 U	1 U	1 U
VINYL CHLORIDE	2	0.5 U	1 U	1 U	1 U

Shaded cell indicates exceedance of the remedial goal.
U - Not detected at associated detection limit.
J - Estimated concentration.

TABLE 2-2

YEAR 1 GROUNDWATER MONITORING RESULTS FOR SITE 7
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

CHEMICAL OF CONCERN	REMEDIAL GOAL	7MW01D				
		May-06	Oct-06		Jan-07	Mar-07
			Sample	Duplicate		
VOLATILE ORGANIC COMPOUNDS (µg/L)						
1,4-DICHLOROBENZENE	75 (1)	0.5 U	1 U	1 U	1 U	1 U
BENZENE	1 (1)	0.5 U	1 U	1 U	1 U	1 U
CHLOROBENZENE	100 (1)	0.5 U	1 U	1 U	1 U	1 U
TRICHLOROETHENE	5 (1)	0.5 U	1 U	1 U	1 U	1 U
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)						
HEXACHLOROBENZENE	1 (1)	-	-	-	-	-
POLYNUCLEAR AROMATIC HYDROCARBONS (µg/L)						
BENZO(A)ANTHRACENE	0.3 (2)	-	-	-	-	-
BENZO(A)PYRENE	0.3 (2)	-	-	-	-	-
BENZO(B)FLUORANTHENE	0.3 (2)	-	-	-	-	-
INDENO(1,2,3-CD)PYRENE	NC (2)	-	-	-	-	-

TABLE 2-2

YEAR 1 GROUNDWATER MONITORING RESULTS FOR SITE 7
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

CHEMICAL OF CONCERN	REMEDIAL GOAL	7MWO3I				
					Mar-07	
		May-06	Oct-06	Jan-07	Sample	Duplicate
VOLATILE ORGANIC COMPOUNDS (µg/L)						
1,4-DICHLOROBENZENE	75 (1)	0.5 U	1 U	1 U	1 U	1 U
BENZENE	1 (1)	0.5 U	1 U	1 U	1 U	1 U
CHLOROBENZENE	100 (1)	0.5 U	1 U	1 U	1 U	1 U
TRICHLOROETHENE	5 (1)	0.5 U	1 U	1 U	1 U	1 U
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)						
HEXACHLOROBENZENE	1 (1)	1 U	1 U	0.2 U	0.2 U	-
POLYNUCLEAR AROMATIC HYDROCARBONS (µg/L)						
BENZO(A)ANTHRACENE	0.3 (2)	-	-	-	-	-
BENZO(A)PYRENE	0.3 (2)	-	-	-	-	-
BENZO(B)FLUORANTHENE	0.3 (2)	-	-	-	-	-
INDENO(1,2,3-CD)PYRENE	NC (2)	-	-	-	-	-

TABLE 2-2

YEAR 1 GROUNDWATER MONITORING RESULTS FOR SITE 7
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

CHEMICAL OF CONCERN	REMEDIAL GOAL	7MW03S				
		May-06	Oct-06	Jan-07 Sample	Jan-07 Duplicate	Mar-07
VOLATILE ORGANIC COMPOUNDS (µg/L)						
1,4-DICHLOROBENZENE	75 (1)	0.5 U	1 U	1 U	1 U	1 U
BENZENE	1 (1)	0.5 U	1 U	1 U	1 U	1 U
CHLOROBENZENE	100 (1)	0.5 U	1 U	1 U	1 U	1 U
TRICHLOROETHENE	5 (1)	0.5 U	1 U	1 U	1 U	1 U
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)						
HEXACHLOROBENZENE	1 (1)	1 U	1 U	0.2 U	0.2 U	0.2 U
POLYNUCLEAR AROMATIC HYDROCARBONS (µg/L)						
BENZO(A)ANTHRACENE	0.3 (2)	-	-	-	-	-
BENZO(A)PYRENE	0.3 (2)	-	-	-	-	-
BENZO(B)FLUORANTHENE	0.3 (2)	-	-	-	-	-
INDENO(1,2,3-CD)PYRENE	NC (2)	-	-	-	-	-

TABLE 2-2

YEAR 1 GROUNDWATER MONITORING RESULTS FOR SITE 7
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

CHEMICAL OF CONCERN	REMEDIAL GOAL	7MW05D			
		May-06	Oct-06	Jan-07	Mar-07
VOLATILE ORGANIC COMPOUNDS (µg/L)					
1,4-DICHLOROBENZENE	75 (1)	0.5 U	1 U	1 U	1 U
BENZENE	1 (1)	0.5 U	1 U	1 U	1 U
CHLOROBENZENE	100 (1)	0.5 U	1 U	1 U	1 U
TRICHLOROETHENE	5 (1)	0.72	1	1	0.9 J
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)					
HEXACHLOROBENZENE	1 (1)	-	-	-	-
POLYNUCLEAR AROMATIC HYDROCARBONS (µg/L)					
BENZO(A)ANTHRACENE	0.3 (2)	-	-	-	-
BENZO(A)PYRENE	0.3 (2)	-	-	-	-
BENZO(B)FLUORANTHENE	0.3 (2)	-	-	-	-
INDENO(1,2,3-CD)PYRENE	NC (2)	-	-	-	-

TABLE 2-2

YEAR 1 GROUNDWATER MONITORING RESULTS FOR SITE 7
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

CHEMICAL OF CONCERN	REMEDIAL GOAL	7MW09S			
		May-06	Oct-06	Jan-07	Mar-07
VOLATILE ORGANIC COMPOUNDS (µg/L)					
1,4-DICHLOROBENZENE	75 (1)	0.5 U	1 U	1 U	1 U
BENZENE	1 (1)	0.5 U	1 U	1 U	1 U
CHLOROBENZENE	100 (1)	0.5 U	1 U	1 U	1 U
TRICHLOROETHENE	5 (1)	0.5 U	1 U	1 U	1 U
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)					
HEXACHLOROBENZENE	1 (1)	1 U	0.14 J	0.2 U	0.20 U
POLYNUCLEAR AROMATIC HYDROCARBONS (µg/L)					
BENZO(A)ANTHRACENE	0.3 (2)	-	-	-	-
BENZO(A)PYRENE	0.3 (2)	-	-	-	-
BENZO(B)FLUORANTHENE	0.3 (2)	-	-	-	-
INDENO(1,2,3-CD)PYRENE	NC (2)	-	-	-	-

TABLE 2-2

YEAR 1 GROUNDWATER MONITORING RESULTS FOR SITE 7
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

CHEMICAL OF CONCERN	REMEDIAL GOAL	7MW12I			
		May-06	Oct-06	Jan-07	Mar-07
VOLATILE ORGANIC COMPOUNDS (µg/L)					
1,4-DICHLOROBENZENE	75 (1)	0.5 U	1 U	1 U	1 U
BENZENE	1 (1)	0.5 U	1 U	1 U	1 U
CHLOROBENZENE	100 (1)	0.5 U	1 U	1 U	1 U
TRICHLOROETHENE	5 (1)	0.86	0.9 J	1	0.7 J
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)					
HEXACHLOROBENZENE	1 (1)	1 U	1 U	0.2 U	0.2 U
POLYNUCLEAR AROMATIC HYDROCARBONS (µg/L)					
BENZO(A)ANTHRACENE	0.3 (2)	-	-	-	-
BENZO(A)PYRENE	0.3 (2)	-	-	-	-
BENZO(B)FLUORANTHENE	0.3 (2)	-	-	-	-
INDENO(1,2,3-CD)PYRENE	NC (2)	-	-	-	-

TABLE 2-2

YEAR 1 GROUNDWATER MONITORING RESULTS FOR SITE 7
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

CHEMICAL OF CONCERN	REMEDIAL GOAL	7MW12S			
		May-06	Oct-06	Jan-07	Mar-07
VOLATILE ORGANIC COMPOUNDS (µg/L)					
1,4-DICHLOROBENZENE	75 (1)	0.5 U	1 U	1 U	1 U
BENZENE	1 (1)	0.5 U	1 U	1 U	1 U
CHLOROBENZENE	100 (1)	1.3	1 J	2	2
TRICHLOROETHENE	5 (1)	0.5 U	1 U	1 U	1 U
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)					
HEXACHLOROBENZENE	1 (1)	1 U	1 U	0.2 U	0.2 U
POLYNUCLEAR AROMATIC HYDROCARBONS (µg/L)					
BENZO(A)ANTHRACENE	0.3 (2)	-	-	-	-
BENZO(A)PYRENE	0.3 (2)	-	-	-	-
BENZO(B)FLUORANTHENE	0.3 (2)	-	-	-	-
INDENO(1,2,3-CD)PYRENE	NC (2)	-	-	-	-

TABLE 2-2

YEAR 1 GROUNDWATER MONITORING RESULTS FOR SITE 7
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

CHEMICAL OF CONCERN	REMEDIAL GOAL	7MW13S						
		May-06		Oct-06		Jan-07	Mar-07	
		Sample	Duplicate	Sample	Duplicate		Sample	Duplicate
VOLATILE ORGANIC COMPOUNDS (µg/L)								
1,4-DICHLOROBENZENE	75 (1)	-	-	-	-	-	-	-
BENZENE	1 (1)	-	-	-	-	-	-	-
CHLOROBENZENE	100 (1)	-	-	-	-	-	-	-
TRICHLOROETHENE	5 (1)	-	-	-	-	-	-	-
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)								
HEXACHLOROBENZENE	1 (1)	1 U	1 U	1 U	1 U	0.2 U	0.21 U	0.22 U
POLYNUCLEAR AROMATIC HYDROCARBONS (µg/L)								
BENZO(A)ANTHRACENE	0.3 (2)	0.05 U	0.05 U	0.07 UJ	0.27 J	0.07 U	0.074 U	0.075 U
BENZO(A)PYRENE	0.3 (2)	0.05 U	0.05 U	0.05 U	0.05 U	0.2 U	0.21 U	0.22 U
BENZO(B)FLUORANTHENE	0.3 (2)	0.05 U	0.05 U	0.08 U	0.08 U	0.08 U	0.18 J	0.086 U
INDENO(1,2,3-CD)PYRENE	NC (2)	0.05 U	0.05 U	0.10 U	0.10 U	0.2 U	0.21 U	0.22 U

1 Remedial goal selected in Interim ROD (Navy, 2004c).
2 Monitoring criterion for protection of GB-classified groundwater.
Shaded cell indicates exceedance of the remedial goal.
U - Not detected at associated detection limit.
J - Estimated concentration.
(-) - Parameter not analyzed.

TABLE 2-3

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS FOR SITE 15
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

PARAMETER	15MW1S	15MW2S		15MW3S	15TW01	15TW02	15TW03
		Sample	Duplicate				
Volatile Organic Compounds (µg/L)							
CHLOROFORM	1 U	1 U	1 U	1 U	1 U	1 U	3
Unfiltered Inorganics (µg/L)							
ALUMINUM	37.4 U	2780	2820	58.7 U	2240 J	78.8 U	137 U
BARIUM	85.1	50.8	52.7	31.4	50.2	78.2	47.7
BERYLLIUM	0.37 U	1.1 U	1.1 U	0.37 U	0.84	0.37 U	0.37 U
CADMIUM	4.5 U	5.0 U	4.7 U	2.5 U	2.5 U	4.4	2.5 U
CALCIUM	26400	11900	12100	18800	8290	16000	34200
CHROMIUM	0.87 J	0.55 U	0.55 U	0.55 U	1.1 U	0.55 U	0.60 U
COBALT	5.1 U	8.4 J	7.8 J	5.1 U	9.5	5.1 U	7.3
COPPER	3.4 U	19.2	21.3	3.4 U	13.9	3.4 U	3.4 U
IRON	24.5 U	32.7 U	36.8 U	7800	427	80.4 U	215
LEAD	1.3 U	1.3 U	1.3 U	1.3 U	2.3	1.3 U	1.8
MAGNESIUM	2980	2000	2050	3780	1210	2200	3080
MANGANESE	4.8	223	227	287	340	41.1	702
POTASSIUM	4630	1540	1600	4390	1780	2120	5700
SODIUM	36200	35400	36200	42600	22600	45400	38300
ZINC	2.9 J	356	365	1.6 U	181	60.9	2.8 U
Filtered Inorganics (µg/L)							
ALUMINUM	25.4 U	35.4 U	2770 J	25.4 U	2160	66.1 U	25.4 U
BARIUM	83.6	12.5	52.2	34.6	50.7	77.5	47.8
BERYLLIUM	0.37 U	0.37 U	1.2 U	0.37 U	0.84	0.37 U	0.37 U
CADMIUM	3.2 U	2.7 U	6.3 U	2.5 U	2.5 U	6.4	2.5 U
CALCIUM	25800	5490	12000	19800	8350	16000	34700
CHROMIUM	0.75 J	0.55 U	0.55 U	0.56 J	0.80 U	0.55 U	0.55 U
COBALT	5.1 U	5.1 U	6.8 J	5.1 U	7.5	5.1 U	5.1 U
COPPER	3.4 U	3.4 U	18.2	3.4 U	15.2	3.4 U	3.4 U
IRON	12.0 U	2030 J	6.6 U	6740 J	366	75.7 U	135
LEAD	1.3 U	1.3 U	1.3 J	1.3 U	1.3 U	1.3 U	1.4
MAGNESIUM	2930	1120	2020	3870	1200	2180	3080
MANGANESE	4.2 J	311 J	226 J	279 J	350	40.1	703
POTASSIUM	4570	1420	1880	4900	1760	2050	5550
SODIUM	35500 J	14600 J	35400 J	43600 J	23200	44900	38100
ZINC	3.2 J	50.5 J	362 J	1.6 U	179	60.4	2.3 U

From Basewide Groundwater Operable Unit Remedial Investigation Update/Feasibility Study (TtNUS, 2004).

TABLE 2-4

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS FOR SITE 18
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

PARAMETER	18TW2		18TW4
	Sample	Duplicate	
Inorganics (µg/L)			
ALUMINUM	189 U	211 U	880
BERYLLIUM	0.6 U	0.6 U	0.79 J
CALCIUM	25000	25200	9640
IRON	306	328	1030
MAGNESIUM	1590 U	1650 U	2630
MANGANESE	111	111	322
POTASSIUM	1660 U	1670 U	2570
SODIUM	9570	9900	15100
Miscellaneous Parameters (mg/L)			
TOTAL DISSOLVED SOLIDS	146	174	111
TOTAL SUSPENDED SOLIDS	5 U	5 U	39

From Basewide Groundwater Operable Unit Remedial Investigation Report (TtNUS, 2002).
U - Not detected at associated detection limit.
J - Estimated concentration.

TABLE 2-5

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS FOR SITE 20
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARIINE BASE NEW LONDON
GROTON, CONNECTICUT

PARAMETER	2WCMW1S	2WCMW2S
Unfiltered Inorganics (μg/L)		
ALUMINUM	180 U	257
ARSENIC	3.2 J	2.0 U
BARIUM	81.4	14.4
CALCIUM	166000	5410
CHROMIUM	3.4	0.61 J
COPPER	3.4 U	3.6 J
IRON	50900	2970
LEAD	1.3 U	2.3 J
MAGNESIUM	41200	1210
MANGANESE	2350	216
POTASSIUM	44000	1390
SODIUM	353000	15200
ZINC	4.1	58.0
Filtered Inorganics (μg/L)		
ALUMINUM	41.0 U	2760 J
ARSENIC	3.4 J	2.0 U
BARIUM	85.2	52.0
CALCIUM	191000	12000
CHROMIUM	2.1	0.55 U
COBALT	5.1 U	9.3 J
COPPER	3.4 U	18.9
IRON	38000 J	7.7 U
MAGNESIUM	33500	2010
MANGANESE	2220 J	225 J
POTASSIUM	29100	1840
SODIUM	190000 J	35200 J
ZINC	2.3 J	361 J

From Basewide Groundwater Operable Unit Remedial Investigation Update/
Feasibility Study Report (TtNUS, 2004).
U - Not detected at associated detection limit.
J - Estimated concentration.

TABLE 2-6

SUMMARY OF DATA FROM 2007 UNDERDRAIN METERING PIT QUARTERLY SAMPLING EVENTS AT SITE 23
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

PARAMETER	CTDEP Criteria		Stormwater Discharge Permit Criterion	23MP01					
	Surface Water Protection	Residential Volatilization		Jun-07		Sep-07	Dec-07		Feb-08
				Sample	Duplicate		Sample	Duplicate	
Volatile Organics (µg/L)									
BENZENE	710	130	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J
BROMODICHLOROMETHANE	2.3	NE	NA	0.3 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
CHLOROFORM	14,100	26	NA	3 J	2 J	0.5 U	0.5 U	0.5 U	0.5 U
CYCLOHEXANE	NE	NE	NA	0.5 U	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U
CIS-1,2-DICHLOROETHENE	NE	830	NA	0.3 J	0.2 J	0.3 J	0.2 J	0.5 U	0.2 J
ISOPROPYLBENZENE	NE	2,800	NA	0.1 J	0.09 J	0.1 J	0.5 U	0.5 UJ	0.5 U
METHYL TERT-BUTYL ETHER	NE	21,000	NA	1	0.9	0.4 J	0.6	0.6	0.7
TETRACHLOROETHENE	88	340	NA	0.3 J	0.3 J	0.4 J	0.3 J	0.2 J	0.3 J
TRICHLOROETHENE	2,340	27	NA	0.4 J	0.3 J	0.5 J	0.4 J	0.3 J	0.4 J
Semivolatile Organics (µg/L)									
1-METHYLNAPHTHALENE	NE	NE	NA	0.2 U	0.2 U	0.2 U	0.96 J	0.048 J	0.21 U
2-METHYLNAPHTHALENE	NE	NE	NA	0.17 J	0.16 J	0.2 U	1.1 J	0.2 UJ	0.21 UJ
4-NITROANILINE	NE	NE	NA	0.2 U	0.2 U	1 UJ	0.75 J	1.0 UR	1.0 UJ
ACENAPHTHENE	NE	NE	NA	0.2 U	0.2 U	0.2 U	0.83 J	0.029 J	0.21 U
ACENAPHTHYLENE	0.3	NE	NA	0.2 U	0.2 U	0.2 U	**0.90 J**	0.20 UJ	0.21 U
ANTHRACENE	1,100,000	NE	NA	0.2 U	0.2 U	0.2 U	0.92 J	0.20 UJ	0.21 U
BENZO(A)ANTHRACENE	0.3	NE	NA	0.07 U	0.07 U	0.041 U	**1.0 J**	0.042 UJ	0.045 U
BENZO(A)PYRENE	0.3	NE	NA	0.2 UJ	0.2 U	0.2 U	**0.35 J**	0.20 U	0.21 U
BENZO(B)FLUORANTHENE	0.3	NE	NA	0.08 U	0.08 U	0.075 U	**0.64 J**	0.078 UJ	0.082 U
BENZO(G,H,I)PERYLENE	NE	NE	NA	0.2 UJ	0.2 U	0.2 U	0.31	0.20 U	0.21 U
BENZO(K)FLUORANTHENE	0.3	NE	NA	0.2 UJ	0.2 UJ	0.2 U	**0.53 J**	0.20 U	0.21 U
CHRYSENE	NE	NE	NA	0.2 U	0.2 U	0.2 U	0.76 J	0.20 UJ	0.21 U
DIBENZO(A,H)ANTHRACENE	NE	NE	NA	0.2 UJ	0.2 U	0.2 U	0.14 J	0.20 U	0.21 U
FLUORANTHENE	3,700	NE	NA	0.2 U	0.2 U	0.2 U	1.1 J	0.20 UJ	0.21 U
FLUORENE	140,000	NE	NA	0.2 U	0.2 U	0.2 U	0.97 J	0.20 UJ	0.21 UJ
HEXACHLOROBENZENE	0.077	NE	NA	1 U	1 U	0.2 U	**1.2 J**	0.20 UJ	0.21 U
HEXACHLOROBUTADIENE	NE	NE	NA	0.2 U	0.2 U	0.48 U	0.64 J	0.099 U	0.21 U
INDENO(1,2,3-CD)PYRENE	NE	NE	NA	0.2 UJ	0.2 U	0.2 U	0.22	0.20 U	0.21 UJ
NAPHTHALENE	NE	NE	NA	0.2 U	0.2 U	0.2 U	1.0 J	0.088 J	0.21 U
PHENANTHRENE	0.3	NE	NA	0.2 U	0.2 U	0.2 U	**0.98 J**	0.20 UJ	0.21 U
PYRENE	110,000	NE	NA	0.2 U	0.2 U	0.2 U	0.84 J	0.20 UJ	0.21 U

TABLE 2-6

SUMMARY OF DATA FROM 2007 UNDERDRAIN METERING PIT QUARTERLY SAMPLING EVENTS AT SITE 23
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

PARAMETER	CTDEP Criteria		Stormwater Discharge Permit Criterion	23MP01					
	Surface Water Protection	Residential Volatilization		Jun-07		Sep-07	Dec-07		Feb-08
				Sample	Duplicate		Sample	Duplicate	
Semivolatile Organics , Filtered (µg/L)									
1-METHYLNAPHTHALENE	NE	NE	NA	NA	NA	NA	NA	NA	0.093 J
2-METHYLNAPHTHALENE	NE	NE	NA	NA	NA	NA	NA	NA	0.2 UJ
4-NITROANILINE	NE	NE	NA	NA	NA	NA	NA	NA	1.0 UJ
ACENAPHTHENE	NE	NE	NA	NA	NA	NA	NA	NA	0.031 J
ACENAPHTHYLENE	0.3	NE	NA	NA	NA	NA	NA	NA	0.2 U
ANTHRACENE	1,100,000	NE	NA	NA	NA	NA	NA	NA	02. U
BENZO(A)ANTHRACENE	0.3	NE	NA	NA	NA	NA	NA	NA	0.042 U
BENZO(A)PYRENE	0.3	NE	NA	NA	NA	NA	NA	NA	0.2 U
BENZO(B)FLUORANTHENE	0.3	NE	NA	NA	NA	NA	NA	NA	0.078 U
BENZO(G,H,I)PERYLENE	NE	NE	NA	NA	NA	NA	NA	NA	0.13 J
BENZO(K)FLUORANTHENE	0.3	NE	NA	NA	NA	NA	NA	NA	0.2 U
CHRYSENE	NE	NE	NA	NA	NA	NA	NA	NA	0.2 U
DIBENZO(A,H)ANTHRACENE	NE	NE	NA	NA	NA	NA	NA	NA	0.2 U]
FLUORANTHENE	3,700	NE	NA	NA	NA	NA	NA	NA	0.2 U
FLUORENE	140,000	NE	NA	NA	NA	NA	NA	NA	0.2 UJ
HEXACHLOROBENZENE	0.077	NE	NA	NA	NA	NA	NA	NA	0.2 U
HEXACHLOROBUTADIENE	NE	NE	NA	NA	NA	NA	NA	NA	0.2 U
INDENO(1,2,3-CD)PYRENE	NE	NE	NA	NA	NA	NA	NA	NA	0.22 J
NAPHTHALENE	NE	NE	NA	NA	NA	NA	NA	NA	0.069 J
PHENANTHRENE	0.3	NE	NA	NA	NA	NA	NA	NA	0.2 U
PYRENE	110,000	NE	NA	NA	NA	NA	NA	NA	0.2 U
Inorganics, Total (µg/L)									
ALUMINUM	NE	NA	NA	473	115	322	38.1	21.8	29.4
ARSENIC	4	NA	NA	3.7 U	3 U	**13.9**	2.2 U	4.7 U	3.1
BARIUM	NE	NA	NA	48.2	52.4	87	55.2	53.4	55.9
CALCIUM	NUT	NA	NA	33,800	35,800	32,000	35,500	34,700	34,300
CHROMIUM	110 (2)	NA	NA	0.94 U	0.81 U	2	0.41	0.28 U	0.38 U
COBALT	NE	NA	NA	0.84 U	0.64 U	0.26 U	0.66	0.53	0.8 U
COPPER	48	NA	60	3 U	3 U	4.2	0.44 U	0.22 U	0.8 U
IRON	NUT	NA	NA	9,190	11,900	70,800	9,860	10,200	4,380
LEAD	13	NA	30	2.2	9.3	8.4	2.5 U	2.2 U	1.4 U
MAGNESIUM	NUT	NA	NA	7,260	7,660	7,020	7,660	7,490	7,450
MANGANESE	NE	NA	NA	661	715	845	858	815	784
NICKEL	880	NA	NA	1.1 U	0.88 U	0.41 U	0.53	0.46	0.64
POTASSIUM	NUT	NA	NA	5,210	5,490	5,270	5,590	5,490	5,150

TABLE 2-6

SUMMARY OF DATA FROM 2007 UNDERDRAIN METERING PIT QUARTERLY SAMPLING EVENTS AT SITE 23
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

PARAMETER	CTDEP Criteria		Stormwater Discharge Permit Criterion	23MP01					
	Surface Water Protection	Residential Volatilization		Jun-07		Sep-07	Dec-07		Feb-08
				Sample	Duplicate		Sample	Duplicate	
Inorganics, Total (µg/L) (Continued)									
SELENIUM	50	NA	NA	1.5 U	2 J	1.5 U	1.5 U	1.5 U	2.2 U
SILVER	12	NA	NA	0.46 U	0.46 U	1.5	0.46 U	0.46 U	0.54 U
SODIUM	NUT	NA	NA	46,900	49,600	52,100	53,400	52,300	50,100
VANADIUM	NE	NA	NA	1.3 U	1.4 U	3.7	0.34 U	0.29 U	0.52 U
ZINC	123	NA	200	21.3 J	22.3	47.1	22.8	20	26.6
Inorganics, Filtered (µg/L)									
ALUMINUM	NE	NA	NA	20.4 J	36.7 J	21.3 J	19.0 U	19.0 U	35.4
ARSENIC	4	NA	NA	3.5 U	2.2 U	1.2 J	1.9 U	1.1 U	2.8
BARIUM	NE	NA	NA	44.6	46.4	50.1	48.9	49.6	56.8
CALCIUM	NUT	NA	NA	33,600	34,700	31,400	33,100	33,400	36,000
CHROMIUM	110 (2)	NA	NA	1.2 U	0.44 U	0.3 J	0.29	0.48	0.38 U
COBALT	NE	NA	NA	0.67 U	0.86 U	0.47 J	0.48	0.51	0.64
IRON	NUT	NA	NA	3,470	3,630	3,600	4,190	4,140	3,750
LEAD	13	NA	30	1.3 J	1.8 J	1.1 U	2.1 U	2.8 U	1.4 U
MAGNESIUM	NUT	NA	NA	7,200	7,480	6,980	7,250	7,300	8,020
MANGANESE	NE	NA	NA	645	664	708	764	770	815
NICKEL	880	NA	NA	1.1 U	0.88 U	0.78 J	1	0.64	0.66
POTASSIUM	NUT	NA	NA	5,090	5,390	5,320	5,360	5,390	5,390
SELENIUM	50	NA	NA	1.5 U	1.7 J	2.4 U	1.5 U	2.3 U	2.2 U
SODIUM	NUT	NA	NA	46,600	48,400	52,600	50,400	51,400	52,100
ZINC	123	NA	200	21.4 J	19.5 J	15	18.6	20.8	26
Petroleum Hydrocarbons (µg/L)									
ETPH (C09-C36)	NE	NE	2,500(1)	55 J	79 U	140 J	160 U	1,600 J	75 U
Petroleum Hydrocarbons, Filtered (µg/L)									
ETPH (C09-C36)	NE	NE	2,500(1)	NA	NA	NA	NA	NA	75 U

1 - Criterion is for oil and grease.
2 - Criterion is for hexavalent chromium.
Shaded cells indicate exceedances of criteria.
NA - Not applicable.
NE - Not established.
NUT Essential nutrient.
U - Not detected at associated detection limit.
J - Estimated concentration.

TABLE 2-7

SELECTION OF HUMAN HEALTH RISK ASSESSMENT EXPOSURE PATHWAYS FOR OPERABLE UNIT 9
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Groundwater	Groundwater	Overburden/ Bedrock Aquifer	Construction Workers	Adult	Ingestion Dermal	On-Site On-Site	None Quant	Construction workers may have dermal contact with groundwater during excavation activities.
				Residents	Adult	Ingestion Dermal	On-Site On-Site	Quant Quant	Groundwater may be used as a potable water source in the future.
					Child	Ingestion Dermal	On-Site On-Site	None None	Exposures to a child resident are less than those for an adult resident
		Air		Construction Workers	Adult	Inhalation	On-site	None	Construction workers exposure via volatilization is expected to be insignificant due to dilution with outdoor air.
				Residents	Adult	Inhalation	On-site	Quant	On-site residents may be exposed to volatile emissions from groundwater while showering.
					Child	Inhalation	On-site	None	Exposures to a child resident are less than those for an adult resident

TABLE 2-8

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 3 GROUNDWATER
REASONABLE MAXIMUM EXPOSURES
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Receptor	Medium	Exposure Route	Cancer Risk	Chemicals with Cancer Risks > 10^{-4}	Chemicals with Cancer Risks > 10^{-5} and ≤ 10^{-4}	Chemicals with Cancer Risks > 10^{-6} and ≤ 10^{-5}	Hazard Index	Chemicals with HI > 1
Construction Worker	Groundwater	Dermal Contact	1.3E-06	- -	- -	- -	0.001	- -

Receptor	Medium	Exposure Route	Cancer Risk	Chemicals with Cancer Risks > 10^{-4}	Chemicals with Cancer Risks > 10^{-5} and ≤ 10^{-4}	Chemicals with Cancer Risks > 10^{-6} and ≤ 10^{-5}	Hazard Index	Chemicals with HI > 1
Adult Resident	Groundwater	Ingestion	5.1E-04	Arsenic	Vinyl Chloride, Benzo(a)pyrene, Dibenzo(a,h)anthracene	1,1,2-Trichloroethane, Indeno(1,2,3-cd)pyrene, alpha-BHC	2.4	Arsenic
		Dermal Contact	8.6E-04	Benzo(a)pyrene, Dibenzo(a,h)anthracene	Indeno(1,2,3-cd)pyrene	alpha-BHC, Arsenic	0.009	- -
		Inhalation[(1)]	1.9E-05	- -	Vinyl Chloride	1,1,2-Trichloroethane	0.04	- -
		Total	1.4E-03	Benzo(a)pyrene, Dibenzo(a,h)anthracene, Arsenic	Vinyl Chloride, Indeno(1,2,3-cd)pyrene	1,1,2-Trichloroethane, alpha-BHC	2.4	Arsenic

Taken from Basewide Groundwater Operable Unit Remedial Investigation Update/Feasibility Study (TtNUS, 2004).

1 Inhalation risk is assumed to be equal to risk from ingestion for volatiles.

TABLE 2-9

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 3 GROUNWATER
CENTRAL TENDENCY EXPOSURES
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Receptor	Medium	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Groundwater	Dermal Contact	4.4E-07	- -	- -	- -	0.0003	- -

Receptor	Medium	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Adult Resident	Groundwater	Ingestion	7.1E-05	- -	Arsenic	Vinyl Chloride, Benzo(a)pyrene, Dibenzo(a,h)anthracene	1.1	Arsenic
		Dermal Contact	1.4E-04	- -	Benzo(a)anthracene, Dibenzo(a,h)anthracene	Indeno(1,2,3-cd)pyrene	0.005	- -
		Inhalation(1)	2.6E-06	- -	- -	Vinyl Chloride	0.02	- -
		Total	2.2E-04	- -	Benzo(a)anthracene, Dibenzo(a,h)anthracene, Arsenic	Vinyl Chloride, Indeno(1,2,3-cd)pyrene	1.1	Arsenic

Taken from Basewide Groundwater Operable Unit Remedial Investigation Update/Feasibility Study (TtNUS, 2004).

1 Inhalation risk is assumed to be equal to risk from ingestion for volatiles.

TABLE 2-10

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 7 GROUNDWATER
REASONABLE MAXIMUM EXPOSURES
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Receptor	Medium	Exposure Route	Cancer Risk	Chemicals with Cancer Risks > 10^{-4}	Chemicals with Cancer Risks > 10^{-5} and ≤ 10^{-4}	Chemicals with Cancer Risks > 10^{-6} and ≤ 10^{-5}	Hazard Index	Chemicals with HI > 1
Construction Worker	Groundwater	Dermal Contact	4.2E-07	- -	- -	- -	0.09	- -
Adult Resident	Groundwater	Ingestion	3.2E-04	Arsenic	Bis(2-ethylhexyl)phthalate, 1,4-Dichlorobenzene, Hexachlorobenzene	Benzene, Trichloroethene	3.8	Arsenic, Chromium
		Dermal Contact	2.9E-04	Hexachlorobenzene	Bis(2-ethylhexyl)phthalate, 1,4-Dichlorobenzene	- -	1.3	- -
		Inhalation(1)	3E-05	- -	1,4-Dichlorobenzene	Benzene, Trichloroethene	0.5	- -
		Total	6.4E-04	Arsenic, Hexachlorobenzene	Bis(2-ethylhexyl)phthalate, 1,4-Dichlorobenzene	Benzene, Trichloroethene	5.6	Arsenic, Chromium

Taken from Basewide Groundwater Operable Unit Remedial Investigation Report (TtNUS, 2002a).

1 Inhalation risk is assumed to be equal to risk from ingestion for volatiles.

TABLE 2-11

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 7 GROUNDWATER
CENTRAL TENDENCY EXPOSURES
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Receptor	Medium	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Groundwater	Dermal Contact	1.0E-07	- -	- -	- -	0.05	- -
Adult Resident	Groundwater	Ingestion	1.2E-05	- -	- -	Arsenic, Hexachlorobenzene	0.2	- -
		Dermal Contact	3.2E-05	- -	Hexachlorobenzene	- -	0.8	- -
		Inhalation(1)	8.5E-08	- -	- -	- -	0.02	- -
		Total	4.4E-05	- -	Hexachlorobenzene	Arsenic, Bis(2-ethylhexyl)phthalate	1.1	- -

Taken from Basewide Groundwater Operable Unit Remedial Investigation Report (TtNUS, 2002a).

1 Inhalation risk is assumed to be equal to risk from ingestion for volatiles.

TABLE 2-12

**COMPARISONS OF SITE 14 GROUNDWATER ANALYTICAL RESULTS
TO SCREENING CRITERIA
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT**

Parameter	S14MW01S	Basewide Background(1)	EPA Region 9 PRG(2)	CTDEP GA/GAA Criterion(3)	EPA MCL(4)	Connecticut MCL(5)	CTDEP RSR Surface Water Protection Criterion(3)
Total Metals (µg/L)							
BARIUM	48.8	227	2600 N	1000	2000	2000	NA
CALCIUM	6890	188000	NA	NA	NA	NA	NA
IRON	1330	28200	11000 N	NA	**300 (6)**	NA	NA
MAGNESIUM	3060	19100	NA	NA	NA	NA	NA
MANGANESE	88.2	11700	880 N	NA	**50 (6)**	NA	NA
POTASSIUM	2780	70800	NA	NA	NA	NA	NA
SODIUM	31500	1900000	NA	NA	NA	NA	NA
Miscellaneous Parameters (mg/L)							
TOTAL DISSOLVED SOLIDS	122 J	6260	NA	NA	500 (6)	NA	NA

Taken from Basewide Groundwater Operable Unit Remedial Investigation Update/Feasibility Study (TtNUS, 2004).

NA - Not available.
RBC - Risk-Based Concentration.
PRG - Preliminary Remediation Goal.
MCL - Maximum Contaminant Level.
1 - 96 Percent Upper Tolerance Limit of site background data. BGOURI Report (TtNUS, 2002a).
2 - EPA Region 9 PRG Table, Residential, 2002b (ICR = 1E-6, HQ = 1.0).
3 - CTDEP Residnetial Remediation Standard Regulations, 1996.
4 - EPA Drinking Water Standards and Health Advisories, 2002a.
5 - Title 19, Health and Safety, the Public Code of the State of Connecticut.
6 - Secondary MCL.
J - Estimated concentration.

TABLE 2-13

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 15
REASONABLE MAXIMUM EXPOSURES
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Receptor	Medium	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Surface/Subsurface Soil	Ingestion	3.5E-07	- -	- -	- -	0.2	- -
		Dermal Contact	1.7E-08	- -	- -	- -	0.003	- -
		Total	3.7E-07	- -	- -	- -	0.2	- -
	Groundwater	Dermal Contact	NC	- -	- -	- -	0.002	- -
		Total All Media	3.7E-07				0.2	
Full-Time Employees	Surface Soil(1)	Ingestion	2.3E-06	- -	- -	Arsenic	0.05	- -
		Dermal Contact	5.2E-07	- -	- -	- -	0.004	- -
		Total	2.8E-06	- -	- -	Arsenic	0.06	- -
Adolescent Trespasser	Surface Soil(1)	Ingestion	1.2E-06	- -	- -	Arsenic	0.07	- -
		Dermal Contact	2.2E-07	- -	- -	- -	0.004	- -
		Total	1.4E-06	- -	- -	Arsenic	0.07	- -
Child Resident	Surface/Subsurface Soil	Ingestion	5.1E-06	- -	- -	Arsenic	0.5	- -
		Dermal Contact	3.1E-07	- -	- -	- -	0.01	- -
		Total	5.4E-06	- -	- -	Arsenic	0.5	- -
Adult Resident	Surface/Subsurface Soil	Ingestion	2.2E-06	- -	- -	Arsenic	0.05	- -
		Dermal Contact	1.7E-07	- -	- -	- -	0.001	- -
		Total	2.4E-06	- -	- -	Arsenic	0.05	- -
	Groundwater	Ingestion	NC	- -	- -	- -	0.2	- -
		Dermal Contact	NC	- -	- -	- -	0.01	- -
		Inhalation(2)	NC	- -	- -	- -	0	- -
		Total	NC	- -	- -	- -	0.3	- -
		Total All Media	2.4E-06				0.3	

From Basewide Groundwater Operable Unit Remedial Investigation Update/Feasibility Study (TtNUS, 2004).
1 - Assumes the pavement is removed.
2 - Inhalation risk is assumed to be equal to risk from ingestion for volatiles.
NC - Not calculated. There were no carcinogenic COPCs identified for groundwater.

TABLE 2-14

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 15
CENTRAL TENDENCY EXPOSURES
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Receptor	Medium	Exposure Route	Cancer Risk	Chemicals with Cancer Risks > 10^{-4}	Chemicals with Cancer Risks > 10^{-5} and ≤ 10^{-4}	Chemicals with Cancer Risks > 10^{-6} and ≤ 10^{-5}	Hazard Index	Chemicals with HI > 1
Construction Worker	Surface/Subsurface Soil	Ingestion	1.2E-07	- -	- -	- -	0.07	- -
		Dermal Contact	1.1E-09	- -	- -	- -	0.0002	- -
		Total	1.2E-07	- -	- -	- -	0.07	- -
	Groundwater	Dermal Contact	NC	- -	- -	- -	0.0005	- -
		Total All Media	1.2E-07				0.07	
Full-Time Workers	Surface Soil[1]	Ingestion	2.7E-07	- -	- -	- -	0.03	- -
		Dermal Contact	1.2E-08	- -	- -	- -	0.0004	- -
		Total	2.9E-07	- -	- -	- -	0.03	- -
Adolescent Trespasser	Surface Soil[1]	Ingestion	7.7E-08	- -	- -	- -	0.01	- -
		Dermal Contact	8.8E-09	- -	- -	- -	0.0006	- -
		Total	8.6E-08	- -	- -	- -	0.01	- -
Child Resident	Surface/Subsurface Soil	Ingestion	8.5E-07	- -	- -	- -	0.2	- -
		Dermal Contact	1.8E-08	- -	- -	- -	0.002	- -
		Total	8.7E-07	- -	- -	- -	0.2	- -
Adult Resident	Surface/Subsurface Soil	Ingestion	3.2E-07	- -	- -	- -	0.03	- -
		Dermal Contact	7.3E-09	- -	- -	- -	0.0002	- -
		Total	3.3E-07	- -	- -	- -	0.03	- -
	Groundwater	Ingestion	NC	- -	- -	- -	0.1	- -
		Dermal Contact	NC	- -	- -	- -	0.005	- -
		Inhalation[2]	NC	- -	- -	- -	0	- -
		Total	NC	- -	- -	- -	0.1	- -
		Total All Media	3.3E-07				0.1	

From Basewide Groundwater Operable Unit Remedial Investigation Update/Feasibility Study (TtNUS, 2004).

1 - Assumes the pavement is removed.
2 - Inhalation risk is assumed to be equal to risk from ingestion for volatiles.
NC - Not calculated. There were no carcinogenic COPCs identified for groundwater.

TABLE 2-15

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 20 GROUNDWATER
REASONABLE MAXIMUM EXPOSURES
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Receptor	Medium	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Groundwater	Dermal Contact	1.3E-09	- -	- -	- -	0.0002	- -
		Inhalation	1.1E-08	- -	- -	- -	--	- -
		Total	1.2E-08	- -	- -	- -	0.0002	- -
Adult Resident	Groundwater	Ingestion	6.4E-05	- -	Arsenic	Benzo(a)pyrene	0.3	- -
		Dermal Contact	2.1E-07	- -	- -	- -	0.0007	- -
		Inhalation(1)	7.7E-07	- -	- -	- -	--	- -
		Total	6.5E-05	- -	Arsenic	Benzo(a)pyrene	0.3	- -

Risks were calculated using organic sampling results from the BGOURI (TtNUS, 2002a) and inorganic sampling results from the BGOURI Update/FS (TtNUS, 2004).

1 - Inhalation risk is assumed to be equal to risk from ingestion for volatiles.

TABLE 2-16

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 20 GROUNDWATER
CENTRAL TENDENCY EXPOSURES
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Receptor	Medium	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Groundwater	Dermal Contact	3.3E-10	- -	- -	- -	0.00004	- -
		Inhalation	2.7E-09	- -	- -	- -	--	- -
		Total	3.0E-09	- -	- -	- -	0.00004	- -
Adult Resident	Groundwater	Ingestion	8.6E-06	- -	- -	Arsenic	0.1	- -
		Dermal Contact	3.1E-08	- -	- -	- -	0.0003	- -
		Inhalation(1)	1.1E-07	- -	- -	- -	--	- -
		Total	8.8E-06	- -	- -	Arsenic	0.1	- -

Risks were calculated using organic sampling results for the BGOURI (TtNUS, 2002a) and inorganic results for the BGOURI Update/FS (TtNUS, 2004).

1 - Inhalation risk is assumed to be equal to risk from ingestion for volatiles.

TABLE 2-17
SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 23
REASONABLE MAXIMUM EXPOSURES
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Receptor	Medium	Exposure Route	Cancer Risk	Chemicals with Cancer Risks > 10-4	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals Contributing to HI > 1
Construction Worker	Groundwater	Dermal Contact	1.3E-09	- -	- -	- -	0.0002	- -
Adult Resident	Groundwater	Ingestion	1.8E-06	- -	- -	Tetrachloroethene	0.01	- -
		Dermal Contact	8.5E-07	- -	- -	- -	0.005	- -
		Inhalation(1)	1.8E-06	- -	- -	Tetrachloroethene	0.008	- -
		Total	4.5E-06	- -	- -	Tetrachloroethene	0.02	- -

1 - Inhalation risk is assumed to be equal to risk fom ingestion for volatiles.

TABLE 2-18

SELECTION OF ECOLOGICAL COPCs IN GROUNDWATER AT SITE 3 - NSA
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Chemicals Detected in Groundwater	Detection Frequency[1]	Minimum Concentration [2]	Maximum Concentration [2]	Location of Maximum Concentration	Background Concentration[3]	Surface Water Screening Value	Ecological Effects Quotient[4]	Retain as a COPC?	Rationale for COPC Selection or Elimination[5]
Volatile Organics (µg/L)									
1,1,2-TRICHLOROETHANE	1/5	2 J	2 J	S3GW3TW2701	--	1200	0.002	NO	BSL
CIS-1,2-DICHLOROETHENE	4/5	0.7 J	3	S3GW2DMW29S04 S3GW3TW2801-D	--	590	0.01	NO	BSL
TOLUENE	2/5	0.2 J	0.3 J	S3GW3TW2701 S3GW3TW2801	--	9.8	0.03	NO	BSL
TOTAL 1,2-DICHLOROETHENE	2/2	0.7 J	3	S3GW2DMW29S04	--	590	0.01	NO	BSL
TRANS-1,2-DICHLOROETHENE	1/5	0.2 J	0.2 J	S3GW3TW2801 S3GW3TW2801-D	--	590	0.0003	NO	BSL
TRICHLOROETHENE	3/5	0.5 J	2	S3GW3TW2801-D	--	47	0.04	NO	BSL
VINYL CHLORIDE	3/5	0.3 J	2 J	S3GW3TW2701	--	NA	--	YES	NTX
Semivolatile Organics (µg/L)									
ACENAPHTHENE	2/5	0.11 J	0.13 J	S3GW3TW2801 S3GW3TW2801-D	--	23	0.01	NO	BSL
BENZO(A)PYRENE	1/5	0.13 J	0.13 J	S3GW3TW2801	--	0.014	9.29	YES	ASL
BENZO(G,H,I)PERYLENE	1/5	0.28	0.28	S3GW3TW2801	--	NA	--	YES	NTX
BENZO(K)FLUORANTHENE	1/5	0.08 J	0.08 J	S3GW3TW2801	--	NA	--	YES	NTX
DIBENZO(A,H)ANTHRACENE	1/5	0.3	0.3	S3GW3TW2801	--	NA	--	YES	NTX
FLUORENE	2/5	0.24 J	0.36 J	S3GW3TW2801	--	3.9	0.1	NO	BSL
INDENO(1,2,3-CD)PYRENE	1/5	0.35	0.35	S3GW3TW2801	--	NA	--	YES	NTX
Pesticides/PCBs(µg/L)									
ALPHA-BHC	1/3	0.025	0.028	S3GW3TW2801	--	2.2	0.01	NO	BSL
BETA-BHC	1/2	0.015 J	0.017	S3GW3TW2801-D	--	2.2	0.01	NO	BSL
Total Metals(µg/L)									
ALUMINUM	2/3	732 J	6780 J	S3GW3TW2701	3560	87	78	YES	ASL
ARSENIC	2/5	2 J	25.4	S3GW2DMW29S04	1.92	150	0.17	NO	BSL
BARIUM	3/3	30	74.8	S3GW3TW3001	227	4	18.7	YES	ASL
CALCIUM	3/3	13300	19100	S3GW3TW3001	188,000	NA	--	NO	EN
CHROMIUM	2/3	5.8	8.4	S3GW3TW2701	49.9	11	0.76	NO	BSL
COPPER	2/3	4.3	14.2	S3GW3TW2801	107	4.8	2.96	YES	ASL
IRON	2/3	18000	20000	S3GW3TW2801	28,200	1000	20	YES	ASL
LEAD	2/3	2.2	8.4	S3GW3TW2701	6.63	1.2	7	YES	ASL
MAGNESIUM	3/3	4410	5770	S3GW3TW3001	191,000	NA	--	NO	EN
MANGANESE	3/3	56.7	764	S3GW3TW2701	11,700	120	6.4	YES	ASL
POTASSIUM	3/3	3650	4540	S3GW3TW2801-D	70,800	NA	--	NO	EN
SODIUM	3/3	52400	68800	S3GW3TW3001	1,900,000	NA	--	NO	EN
VANADIUM	2/3	12.1	12.1	S3GW3TW2701 S3GW3TW2801	10.2	NA	--	YES	NTX

TABLE 2-18

SELECTION OF ECOLOGICAL COPCs IN GROUNDWATER AT SITE 3 - NSA
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Chemicals Detected in Groundwater	Detection Frequency(1)	Minimum Concentration (2)	Maximum Concentration (2)	Location of Maximum Concentration	Background Concentration(3)	Surface Water Screening Value	Ecological Effects Quotient(4)	Retain as a COPC?	Rationale for COPC Selection or Elimination(5)
Filtered Metals(ug/L)									
ARSENIC-FILTERED	2/5	2 J	3.5	S3GW2DMW29S04-F	2.55	150	0.02	NO	BSL
BARIUM-FILTERED	3/3	23.1	75.6	S3GW3TW3001-F	124	4	18.9	YES	ASL
CALCIUM-FILTERED	3/3	13800	19100	S3GW3TW3001-F	152,000	NA	--	NO	EN
IRON-FILTERED	2/3	12000	15200	S3GW3TW2801-F-D	25,300	1000	15.2	YES	ASL
MAGNESIUM-FILTERED	3/3	3730	5810	S3GW3TW3001-F	150,000	NA	--	NO	EN
MANGANESE-FILTERED	3/3	58.6	496	S3GW3TW2701-F	9,400	120	4.13	YES	ASL
POTASSIUM-FILTERED	3/3	3650	4870	S3GW3TW2801-F-D	60,000	NA	--	NO	EN
SODIUM-FILTERED	3/3	55600	69400	S3GW3TW3001-F	1,580,000	NA	--	NO	EN

Taken from Basewide Groundwater Operable Unit Remedial Investigaiton Update/Feasibility Study (TtNUS, 2004).

1 Sample and duplicate were counted as one sample when calculating the frequency of detection.
2 Sample and duplicate were counted as separate samples in determining the minimum and maximum concentrations.
3 Source of the background concentrations is Atlantic, April 1995. Background concentrations of Inorganics in Soil - NSB-NLON.
4 The ecological effects quotient was calculated by dividing the maximum concentration by the screening value.
5 Rationale codes for contaminant selection or deletion:
For Selection as a COPC:
ASL = Above COPC screening level.
NTX = No toxicity information available.
For Elimination as a COPC:
BSL = Below COPC screening level.
EN = Essential Nutrient.

The background concentrations are presented for informational purposes only and were not used in the selection of COPCs.
Shaded name indicates that the constituent was selected as a COPC. Shaded values indicate that the site concentration(s) exceeds this particular criterion.
"--" Unavailable; background concentrations are not available for organic chemicals and an EEQ could not be calculated due to the lack of screening values.
J = Estimated concentration.

TABLE 2-19

SITE 3 REMEDIAL GOALS
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Chemical of Concern	Groundwater Criteria		Remedial Goal
	Federal MCL[(1)]	Connecticut RSRs for Groundwater[(2)]	
Volatile Organic Compounds (µg/L)			
Trichloroethene	5	5	5
Vinyl Chloride	2	2[A] / 1.6[B]	1.6

1 Maximum Contaminant Level (MCL) for drinking water (EPA, 2004).
2 Connecticut Remediation Standard Regulations
A - Groundwater Protection Criteria for groundwater classified as GA (CTDEP, 1996).
B - Groundwater Volatilization Criteria (CTDEP, 2007).

TABLE 2-20

SITE 7 REMEDIAL GOALS
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Chemical of Concern	Groundwater Criteria		Remedial Goal
	Federal MCL[(1)]	Connecticut RSRs for Groundwater[(2)]	
Volatile Organic Compounds (µg/L)			
1,4-Dichlorobenzene	75	75	75
Benzene	5	1	1
Chlorobenzene	100	100	100
Trichloroethene	5	5	5
Vinyl Chloride	2	2[A] / 1.6[B]	1.6
Semivolatile Organic Compounds (µg/L)			
Hexachlorobenzene	1	1	1

1 Maximum Contaminant Level (MCL) for drinking water (EPA, 2004).
2 Connecticut Remediation Standard Regulations;
A - Groundwater Protection Criteria for groundwater classified as GA (CTDEP, 1996).
B - Groundwater Volatilization Criteria (CTDEP, 2007).

TABLE 2-21

ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs FOR GROUNDWATER
ALTERNATIVES GW1-1, GW2-1, AND GW3-1 - NO ACTION
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
Federal				
Cancer Slope Factors	Not Applicable	To Be Considered (TBC)	These are guidance values used in risk assessment to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	The No Action Alternatives would result in unacceptable risks from exposure to contaminated groundwater. Because no restrictions on groundwater use would be implemented under the No Action Alternatives, future groundwater use could result in unacceptable risks to receptors.
References Doses	Not Applicable	TBC	These are guidance values used in risk assessment to evaluate the potential non-carcinogenic hazard caused by exposure to contaminants.	The No Action Alternatives would result in unacceptable risks from exposure to contaminated groundwater. Because no restrictions on groundwater use would be implemented under the No Action Alternatives, future groundwater use could result in unacceptable risks to receptors.
Guidelines for Carcinogen Risk Assessment	EPA/630/P-03/001F (March 2005)	TBC	Guidance for assessing cancer risk from exposures to pollutants and other agents in the environment. As part of the characterization process, explicit evaluations are made of the hazard and risk potential for susceptible lifestages, including children.	The No Action Alternatives would result in unacceptable risks from exposure to contaminated groundwater. Because no restrictions on groundwater use would be implemented under the No Action Alternatives, future groundwater use could result in unacceptable risks to receptors.

TABLE 2-21

ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs FOR GROUNDWATER ALTERNATIVES GW1-1, GW2-1, AND GW3-1 - NO ACTION
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
Federal (continued)				
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA/630/R-03/003F (March 2005)	TBC	Guidance for assessing cancer risks to children. Addresses a number of issues pertaining to cancer risks associated with early-life exposures and also provides specific guidance on potency adjustments for carcinogens acting through the mutagenic mode of action.	The No Action Alternatives would result in unacceptable risks from exposure to contaminated groundwater. Because no restrictions on groundwater use would be implemented under the No Action Alternatives, future groundwater use could result in unacceptable risks to receptors.
State of Connecticut				
Remediation Standard Regulations	CGS 22a-133k; RCSA 22a-133k - 1 through 3	Applicable	This regulation provides specific numerical cleanup criteria for contaminants in groundwater. Requirements are based on groundwater in the area being classified by the state as GB.	The No Action Alternatives would not meet this standard because no action would be taken to determine if regulatory standards continued to be exceeded.

TABLE 2-22

ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs FOR GROUNDWATER
ALTERNATIVES GW1-2 AND GW2-2 - SELECTED REMEDY
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
Federal				
Cancer Slope Factors	Not Applicable	To Be Considered (TBC)	These are guidance values used in risk assessment to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Alternatives would prevent exposure to contaminated groundwater and monitor the migration and degradation of contaminants until concentrations have achieved acceptable levels that meet human health concerns.
Reference Doses	Not Applicable	TBC	These are guidance values used in risk assessment to evaluate the potential non-carcinogenic hazard caused by exposure to contaminants.	Alternatives would prevent exposure to contaminated groundwater and monitor the migration and degradation of contaminants until concentrations have achieved acceptable levels that meet human health concerns.
Guidelines for Carcinogen Risk Assessment	EPA/630/P-03/001F (March 2005)	TBC	Guidance for assessing cancer risk from exposures to pollutants and other agents in the environment. As part of the characterization process, explicit evaluations are made of the hazard and risk potential for susceptible lifestages, including children.	Alternatives will meet this standard because potential carcinogenic risks caused by exposure to contaminants will be addressed.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA/630/R-03/003F (March 2005)	TBC	Guidance for assessing cancer risks to children. Addresses a number of issues pertaining to cancer risks associated with early-life exposures and also provides specific guidance on potency adjustments for carcinogens acting through the mutagenic mode of action.	Alternatives will meet this standard because potential carcinogenic risks caused by exposure to contaminants will be addressed.

TABLE 2-22

ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs FOR GROUNDWATER
ALTERNATIVES GW1-2 AND GW2-2 - SELECTED REMEDY
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
State of Connecticut				
Remediation Standard Regulations	CGS 22a-133k; RCSA 22a-133k - 1 through 3	Applicable	This regulation provides specific numerical cleanup criteria for contaminants in groundwater. Requirements are based on groundwater in the area being classified by the state as GB.	Alternatives will meet these standards by restricting access to contaminated GB groundwater through institutional controls (NSB-NLON Site Use Restrictions document for as long as the Navy owns the property) or environmental land use restrictions (if the Navy transfers ownership of the property). Groundwater monitoring would be conducted to track the location, migration, and degradation of contaminants until concentrations have achieved acceptable levels.

TABLE 2-23

ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs FOR GROUNDWATER
ALTERNATIVES GW1-2 AND GW2-2 - SELECTED REMEDY
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
Federal				
Clean Water Act, Section 403, Pretreatment Regulations	Section 403	Potentially Applicable	General pretreatment requirements for discharge to a publicly owned treatment works (POTW).	Groundwater extracted during groundwater monitoring activities under this alternative would require testing and disposal. Discharge to a POTW would be considered for disposal of the groundwater, and these requirements would be met if determined to be applicable.
State of Connecticut				
Hazardous Waste Management: Generator and Handler Requirements	RCSA § 22a-449(c) 100-101	Applicable	Connecticut is delegated to administer the federal Resource Conservation and Recovery Act statute through its state regulations. These sections establish standards for listing and identification of hazardous waste. The standards of 40 CFR 260-261 are incorporated by reference.	Waste generated during the installation of monitoring wells and monitoring activities under these alternatives will be properly characterized for disposal. Any waste determined to be hazardous through characterization will be managed in accordance with these regulations.
Hazardous Waste Management: Treatment, Storage, or Disposal Facility Standards	RCSA § 22a-449(c) 104	Applicable	These sections establish standards for treatment, storage, and disposal facilities. The standards of 40 CFR 264 are incorporated by reference.	Any hazardous waste generated during the installation of monitoring wells and monitoring activities and temporarily stored on site will be managed in accordance with these regulations.

TABLE 2-23

ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs FOR GROUNDWATER
ALTERNATIVES GW1-2 AND GW2-2 - SELECTED REMEDY
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
State of Connecticut (continued)				
Standards of Water Quality/Water Quality Standards (WQSs) IV	CGS 22a-426 and promulgated standards	Applicable	Standards have been promulgated in accordance with GCS22a-426 of the Connecticut General Statutes to preserve and enhance the quality of state groundwater and surface water. Groundwater at the sites is classified as GB.	These standards for groundwater will be met through monitoring of natural degradation processes. Institutional controls will prevent the aquifer from being used as a water supply until these standards are attained.
Connecticut Regulations for the Well Drilling Industry	RSCA 25-128-33 through 64	Applicable	These rules apply mainly to any new water supply or withdrawal wells. The rules specify that non-water supply wells must be constructed so that they are not a source or cause of groundwater contamination. Procedures for abandonment of wells apply to both water wells and other types of wells.	Non-water supply wells will not be constructed on the site unless it can be shown that they will not be a source of or cause groundwater contamination.
Connecticut Water Pollution Control Act - Permitting Regulations	RSCA 22a-430 1-8	Relevant and Appropriate	Establishes permitting requirements for discharges to surface water, groundwater, and POTWs.	If any remedial activities result in any direct discharges to surface water or groundwater, they must comply with the substantive requirements of these regulations. Specific criteria may be established for discharges so that numeric criteria established in the WQSs are not violated.

TABLE 2-23

ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs FOR GROUNDWATER ALTERNATIVES GW1-2 AND GW2-2 - SELECTED REMEDY OPERABLE UNIT 9 RECORD OF DECISION NAVAL SUBMARINE BASE NEW LONDON GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
State of Connecticut (continued)				
Connecticut Environmental Land Use Restriction Regulations	RCSA 22A-133q-1	Applicable	Requirements to prevent disturbance of contaminated soil and to ensure that contaminated groundwater is not used for human consumption.	Implementation of environmental land use restrictions including deed restrictions.
Connecticut Soil Vapor Remediation Standards Regulations	RCSA 22a-133k-3(c)	Applicable	These standards establish volatilization criteria to address volatile organic substances in groundwater and soil vapor.	For areas where data show the potential for an unacceptable indoor inhalation risk, remedial actions (e.g., sub-slab depressurization systems) will be applied, as needed, to comply with the substantive provisions of these regulations.

TABLE 2-24

ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs FOR GROUNDWATER ALTERNATIVES GW1-2 AND GW2-2 – SELECTED REMEDY OPERABLE UNIT 9 RECORD OF DECISION NAVAL SUBMARINE BASE NEW LONDON GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
FEDERAL				
Coastal Zone Management Act	16 USC Parts 1451 et. seq.	Applicable	Requires that any actions must be conducted in a manner consistent with state-approved management programs.	The actions associated with these alternatives would comply with the substantive requirements of this act.
Floodplain Management	40 C.F.R. §6.302(b); Appendix A	Applicable	This regulation codifies standards established under Executive Order 11988 and requires action to avoid long- and short-term impacts associated with occupancy and modifications related to floodplain development, wherever there is a practicable alternative. Promotes the preservation and restoration of floodplains so that their natural and beneficial value can be realized.	If there is no practicable alternative to groundwater monitoring activities within the 100-year floodplain, all practicable means will be taken to limit harm to and preserve beneficial values of floodplains.
Protection of Wetlands	40 C.F.R. §6.302(a); Appendix A	Applicable	This regulation codifies standards established under Executive Order 11990. Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. If activity takes place, impacts must be minimized to the maximum extent.	If there is no practicable alternative to groundwater monitoring activities that may impact wetlands, measures will be taken to limit impacts.
Clean Water Act Guidelines for Specification of Disposal Sites for Dredged or Fill Material	33 USC §1344; Section 404(b)(1) 40 C.F.R. Parts 230 and 231 and 33 C.F.R. Parts 320 through 323	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. If activity takes place, impacts must be minimized to the maximum extent. This act controls discharges of dredged or fill material to protect aquatic ecosystems.	These alternatives may include installation, maintenance and/or operation of monitoring wells in or near a wetland. Any remedial activities that will alter wetlands will be conducted in accordance with these standards.

TABLE 2-24

ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs FOR GROUNDWATER ALTERNATIVES GW1-2 AND GW2-2 – SELECTED REMEDY OPERABLE UNIT 9 RECORD OF DECISION NAVAL SUBMARINE BASE NEW LONDON GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
STATE OF CONNECTICUT				
Connecticut Coastal Management Act	CGS §22a-444	Applicable	The sites are in a coastal zone management area; therefore, requirements for site planning must include approval of activities within the coastal zone to minimize project impacts to this area.	The activities associated with these alternatives would comply with the substantive requirements of this act.
Inland Wetland and Watercourses Act and Regulations	CGS 22a-36 through 45; RCSA 22a-39-1 through 15	Applicable	These standards regulate any operation in or affecting an inland wetland or watercourse, involving removal or deposition of material or any obstruction, alteration, or pollution of such wetlands. The standards incorporate local wetland regulations, which include additional substantive requirements and a wetland and watercourse boundary map for the Town of Groton.	If there is no practicable alternative to groundwater monitoring activities that may impact designated wetlands or watercourses, measures will be taken to limit impacts.

TABLE 2-25

ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs FOR GROUNDWATER
ALTERNATIVE GW2-3 – EXTRACTION AND OFF-SITE DISCHARGE
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
Federal				
Cancer Slope Factors	Not Applicable	To Be Considered (TBC)	These are guidance values used in risk assessment to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Alternative would remove contaminated groundwater from the sites, pre-treat the extracted water if necessary, and discharge the water to the publicly owned treatment works (POTW) for final treatment and discharge. After removal of groundwater with contaminant concentrations greater than acceptable levels from the sites, there would be no remaining unacceptable risks to human health.
Reference Doses	Not Applicable	TBC	These are guidance values used in risk assessment to evaluate the potential non-carcinogenic hazard caused by exposure to contaminants.	Alternative would remove contaminated groundwater from the sites, pre-treat the extracted water, if necessary, and discharge the water to the POTW for final treatment and discharge. After removal of groundwater with contaminant concentrations greater than acceptable levels from the sites, there would be no remaining unacceptable risks to human health.
Guidelines for Carcinogen Risk Assessment	EPA/630/P-03/001F (March 2005)	TBC	Guidance for assessing cancer risk from exposures to pollutants and other agents in the environment. As part of the characterization process, explicit evaluations are made of the hazard and risk potential for susceptible lifestages, including children.	Alternative will meet this standard because potential carcinogenic risks caused by exposure to contaminants will be addressed.

TABLE 2-25

ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs FOR GROUNDWATER
ALTERNATIVE GW2-3 – EXTRACTION AND OFF-SITE DISCHARGE
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
Federal (continued)				
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA/630/R-03/003F (March 2005)	TBC	Guidance for assessing cancer risks to children. Addresses a number of issues pertaining to cancer risks associated with early-life exposures and also provides specific guidance on potency adjustments for carcinogens acting through the mutagenic mode of action.	Alternative will meet this standard because potential carcinogenic risks caused by exposure to contaminants will be addressed.
State of Connecticut				
Remediation Standard Regulations	CGS 22a-133k; RCSA 22a-133k - 1 through 3	Applicable	This regulation provides specific numerical cleanup criteria for contaminants in groundwater. Requirements are based on groundwater in the area being classified by the state as GB.	Groundwater extraction would continue until contaminants concentrations have achieved acceptable levels.

TABLE 2-26

ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs FOR GROUNDWATER
ALTERNATIVE GW2-3 - EXTRACTION AND OFF-SITE DISCHARGE
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
Federal				
Clean Water Act, Section 403, Pretreatment Regulations	Section 403	Potentially Applicable	General pretreatment requirements for discharge to a publicly owned treatment works (POTW). If remedial activities include such a discharge to the local sanitary sewer, pre-treatment standards would be Applicable or Relevant and Appropriate Requirements (ARARs). Standards would be enforced through the state program.	The extracted water may require pre-treatment prior to discharge to the sanitary sewer system. Groundwater extracted during groundwater monitoring activities under this alternative will require testing and disposal. Discharge to a POTW would be considered for disposal of the groundwater, and these requirements would be met if determined to be applicable.
State of Connecticut				
Hazardous Waste Management: Generator and Handler Requirements	RCSA § 22a-449(c) 100-101	Applicable	Connecticut is delegated to administer the federal Resource Conservation and Recovery Act statute through its state regulations. These sections establish standards for listing and identification of hazardous waste. The standards of 40 CFR 260-261 are incorporated by reference.	Waste generated during the installation of extraction wells and extraction activities, as well as monitoring, under this alternative will be properly characterized for disposal. Any waste determined to be hazardous through characterization will be managed in accordance with these regulations.
Hazardous Waste Management: Treatment, Storage, or Disposal Facility Standards	RCSA § 22a-449(c) 104	Applicable	These sections establish standards for treatment, storage, and disposal facilities. The standards of 40 CFR 264 are incorporated by reference.	Any hazardous waste generated during the installation of extraction wells and extraction activities, as well as monitoring, and temporarily stored on site will be managed in accordance with these regulations.

TABLE 2-26

ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs FOR GROUNDWATER
ALTERNATIVE GW2-3 - EXTRACTION AND OFF-SITE DISCHARGE
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
State of Connecticut (continued)				
Standards of Water Quality/Water Quality Standards (WQSs) IV	CGS 22a-426 and promulgated standards	Applicable	Standards have been promulgated in accordance with GCS22a-426 of the Connecticut General Statutes to preserve and enhance the quality of state groundwater and surface water. Groundwater at the sites is classified as GB.	These standards for groundwater will be met through monitoring of natural degradation processes. Institutional controls will prevent the aquifer from being used as a water supply until these standards are attained.
Connecticut Water Pollution Control Act	RCSA §22a - 416 to 599	Applicable	The regulations govern the treatment and discharge of water into surface water bodies in the state.	Applicable sections of the POTW permit would be used to determine pre-treatment requirements for extracted groundwater.
Connecticut Regulations for the Well Drilling Industry	RSCA 25-128-33 through 64	Applicable	These rules apply mainly to any new water supply or withdrawal wells. The rules specify that non-water supply wells must be constructed so that they are not a source or cause of groundwater contamination. Procedures for abandonment of wells apply to both water wells and other types of wells.	Non-water supply wells will not be constructed on the site unless it can be shown that they will not be a source or cause of groundwater contamination.
Connecticut Water Pollution Control Act - Permitting Regulations	RSCA 22a-430 1-8	Relevant and Appropriate	Establishes permitting requirements for discharges to surface water, groundwater, and POTWs.	If any remedial activities result in any direct discharges to surface water or groundwater, they must comply with the substantive requirements of these regulations. Specific criteria may be established for discharges so that numeric criteria established in the WQSs are not violated.

TABLE 2-26

ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs FOR GROUNDWATER
ALTERNATIVE GW2-3 - EXTRACTION AND OFF-SITE DISCHARGE
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
State of Connecticut (continued)				
Connecticut Environmental Land Use Restriction Regulations	RCSA 22A-133q-1	Applicable	Requirements to prevent disturbance of contaminated soil and to ensure that contaminated groundwater is not used for human consumption.	Implementation of environmental land use restrictions including deed restrictions.
Connecticut Environmental Land Use Restriction Regulations	RCSA 22A-133q-1	Applicable	Requirements to prevent disturbance of contaminated soil and to ensure that contaminated groundwater is not used for human consumption.	Implementation of environmental land use restrictions including deed restrictions.

TABLE 2-27

ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs FOR GROUNDWATER ALTERNATIVE GW2-3 – EXTRACTION AND OFF-SITE DISCHARGE OPERABLE UNIT 9 RECORD OF DECISION NAVAL SUBMARINE BASE NEW LONDON GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
FEDERAL				
Coastal Zone Management Act	16 USC Parts 1451 et. seq.	Applicable	Requires that any actions must be conducted in a manner consistent with state-approved management programs.	The actions associated with Alternative GW2-3 would comply with the substantive requirements of this act.
Floodplain Management	40 C.F.R. §6.302(b); Appendix A	Applicable	This regulation codifies standards established under Executive Order 11988 and requires action to avoid long- and short-term impacts associated with occupancy and modifications related to floodplain development, wherever there is a practicable alternative. Promotes the preservation and restoration of floodplains so that their natural and beneficial value can be realized.	If there is no practicable alternative to the extraction and discharge remedy within the 100-year floodplain, all practicable means will be taken to limit harm to and preserve beneficial values of floodplains.
Protection of Wetlands	40 C.F.R. §6.302(a); Appendix A	Applicable	This regulation codifies standards established under Executive Order 11990. Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. If activity takes place, impacts must be minimized to the maximum extent.	If there is no practicable alternative to implementing the extraction and discharge remedy in a manner that may impact wetlands, measures will be taken to limit impacts.
Clean Water Act Guidelines for Specification of Disposal Sites for Dredged or Fill Material	33 USC §1344; Section 404(b)(1) 40 C.F.R. Parts 230 and 231 and 33 C.F.R. Parts 320 through 323	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. If activity takes place, impacts must be minimized to the maximum extent. This act controls discharges of dredged or fill material to protect aquatic ecosystems.	This alternative includes installation, maintenance and/or operation of the extraction and off-site discharge remedy in or near a wetland. Any remedial activities that will alter wetlands will be conducted in accordance with these standards.

TABLE 2-27

ASSESSMENT OF LOCATION-SPECIFIC ARARs AND TBCs FOR GROUNDWATER ALTERNATIVE GW2-3 – EXTRACTION AND OFF-SITE DISCHARGE OPERABLE UNIT 9 RECORD OF DECISION NAVAL SUBMARINE BASE NEW LONDON GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
STATE OF CONNECTICUT				
Connecticut Coastal Management Act	CGS §22a-444	Applicable	The site is in a coastal zone management area; therefore, requirements for site planning must include approval of activities within the coastal zone to minimize project impacts to this area.	The activities associated with Alternative GW2-3 would comply with the substantive requirements of this act.
Inland Wetland and Watercourses Act and Regulations	CGS 22a-36 through 45; RCSA 22a-39-1 through 15	Applicable	These standards regulate any operation in or affecting an inland wetland or watercourse, involving removal or deposition of material or any obstruction, alteration, or pollution of such wetlands. The standards incorporate local wetland regulations, which include additional substantive requirements and a wetland and watercourse boundary map for the Town of Groton.	If there is no practicable alternative to implementing the extraction and discharge remedy in a manner that may impact designated wetlands or watercourses, measures will be taken to limit impacts.

TABLE 2-28

ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs FOR GROUNDWATER
ALTERNATIVE GW3-2 - SELECTED REMEDY
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
Federal				
Cancer Slope Factors	Not Applicable	To Be Considered (TBC)	These are guidance values used in risk assessment to evaluate the potential carcinogenic hazard caused by exposure to contaminants.	Alternatives would prevent exposure to contaminated groundwater until concentrations have achieved acceptable levels that meet human health concerns.
Reference Doses	Not Applicable	TBC	These are guidance values used in risk assessment to evaluate the potential non-carcinogenic hazard caused by exposure to contaminants.	Alternatives would prevent exposure to contaminated groundwater until concentrations have achieved acceptable levels that meet human health concerns.
Guidelines for Carcinogen Risk Assessment	EPA/630/P-03/001F (March 2005)	TBC	Guidance for assessing cancer risk from exposures to pollutants and other agents in the environment. As part of the characterization process, explicit evaluations are made of the hazard and risk potential for susceptible lifestages, including children.	Alternative will meet this standard because potential carcinogenic risks caused by exposure to contaminants will be addressed.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA/630/R-03/003F (March 2005)	TBC	Guidance for assessing cancer risks to children. Addresses a number of issues pertaining to cancer risks associated with early-life exposures and also provides specific guidance on potency adjustments for carcinogens acting through the mutagenic mode of action.	Alternative will meet this standard because potential carcinogenic risks caused by exposure to contaminants will be addressed.

TABLE 2-28

ASSESSMENT OF CHEMICAL-SPECIFIC ARARs AND TBCs FOR GROUNDWATER
ALTERNATIVE GW3-2 - SELECTED REMEDY
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
State of Connecticut				
Remediation Standard Regulations	CGS 22a-133k; RCSA 22a-133k - 1 through 3	Applicable	This regulation provides specific numerical cleanup criteria for contaminants in groundwater. Requirements are based on groundwater in the area being classified by the state as GB.	Alternatives will meet these standards by restricting access to contaminated GB groundwater through institutional controls (NSB-NLON Site Use Restrictions document for as long as the Navy owns the property) or environmental land use restrictions if the Navy transfers ownership of the property).

TABLE 2-29

ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs FOR GROUNDWATER
ALTERNATIVE GW3-2 - SELECTED REMEDY
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

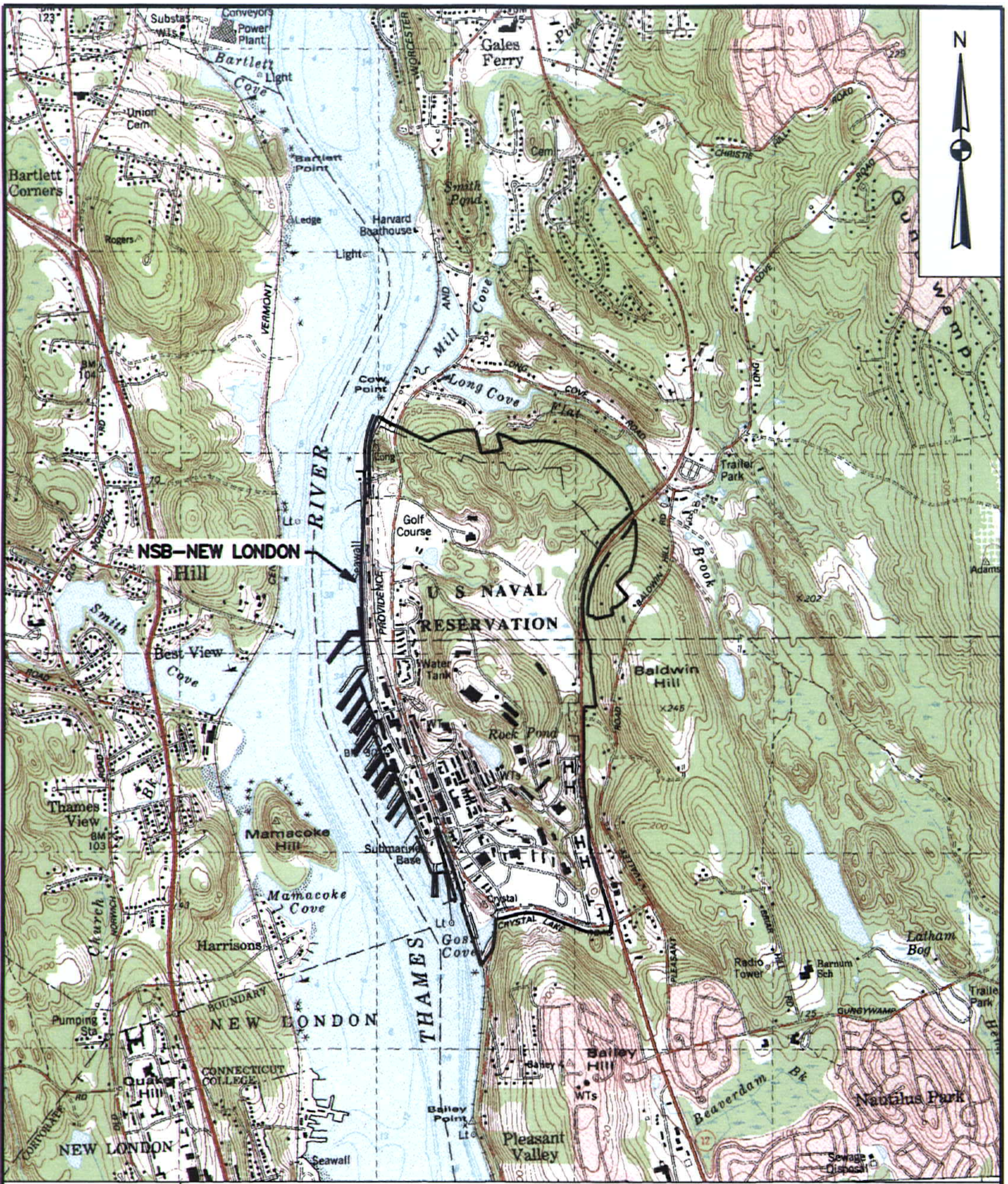
Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
State of Connecticut				
Standards of Water Quality/Water Quality Standards (WQSs) IV	CGS 22a-426 and promulgated standards	Applicable	Standards have been promulgated in accordance with GCS22a-426 of the Connecticut General Statutes to preserve and enhance the quality of state groundwater and surface water. Groundwater at the sites is classified as GB.	These standards for groundwater will be met through monitoring of natural degradation processes. Institutional controls will prevent the aquifer from being used as a water supply until these standards are attained.
Connecticut Regulations for the Well Drilling Industry	RSCA 25-128-33 through 64	Applicable	These rules apply mainly to any new water supply or withdrawal wells. The rules specify that non-water supply wells must be constructed so that they are not a source or cause of groundwater contamination. Procedures for abandonment of wells apply to both water wells and other types of wells.	Non-water supply wells will not be constructed on the site unless it can be shown that they will not be a source or cause of groundwater contamination.
Connecticut Water Pollution Control Act - Permitting Regulations	RSCA 22a-430 1-8	Relevant and Appropriate	Establishes permitting requirements for discharges to surface water, groundwater, and POTWs.	If any remedial activities result in any direct discharges to surface water or groundwater, they must comply with the substantive requirements of these regulations. Specific criteria may be established for discharges so that numeric criteria established in the WQSs are not violated.

TABLE 2-29

ASSESSMENT OF ACTION-SPECIFIC ARARs AND TBCs FOR GROUNDWATER
ALTERNATIVE GW3-2 - SELECTED REMEDY
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

Requirement	Citation	Status	Synopsis of Requirement	Evaluation/Action to be Taken
State of Connecticut (continued)				
Connecticut Environmental Land Use Restriction Regulations	RCSA 22A-133q-1	Applicable	Requirements to prevent disturbance of contaminated soil and to ensure that contaminated groundwater is not used for human consumption.	Implementation of environmental land use restrictions including deed restrictions.
Connecticut Soil Vapor Remediation Standards Regulations	RCSA 22a-133k-3(c)	Applicable	These standards establish volatilization criteria to address volatile organic substances in groundwater and soil vapor.	For areas where data show the potential for an unacceptable indoor inhalation risk, remedial actions (e.g., sub-slab depressurization systems) will be applied, as needed, to comply with the substantive provisions of these regulations.

ACAD: 0894CM27.dwg 02/29/08 MF PIT



SOURCE: QUADRANGLE MAP UNCASVILLE, CONNECTICUT 1984.

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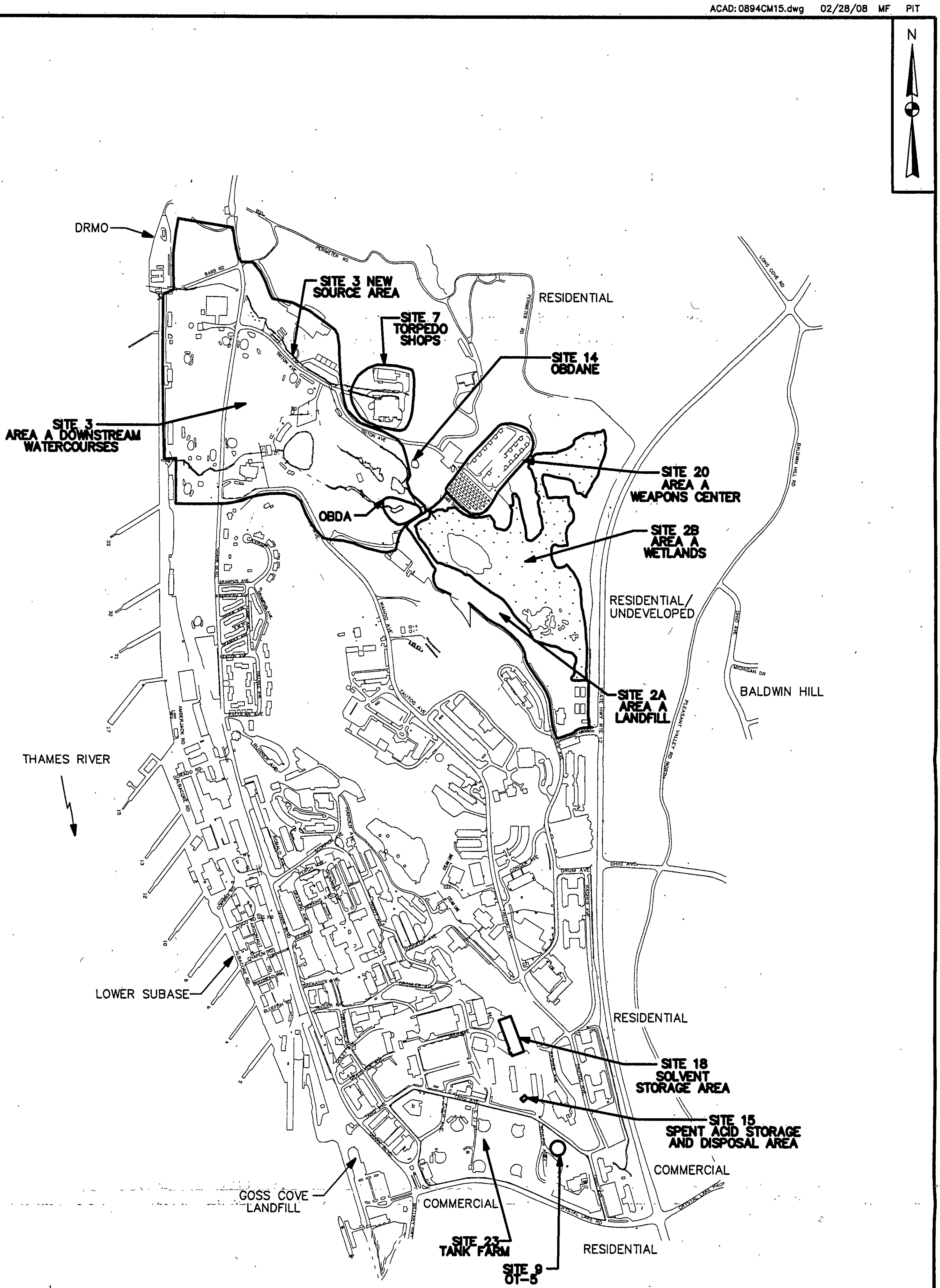
SCALE IN FEET

DRAWN BY MF	DATE 2/29/08	Tetra Tech NUS, Inc.	LOCATION MAP OPERABLE UNIT 9 - BASEWIDE GROUNDWATER RECORD OF DECISION NSB-NLON, GROTON, CONNECTICUT	CONTRACT NO. 0894	
CHECKED BY	DATE			OWNER NO. 0431	
REVISED BY	DATE			APPROVED BY CAN	DATE 2/29/08
SCALE AS NOTED				DRAWING NO. FIGURE 2-1	REV. 0

FORM CADD NO. TTNUS-AV.DWG – REV 1 –9/10/98



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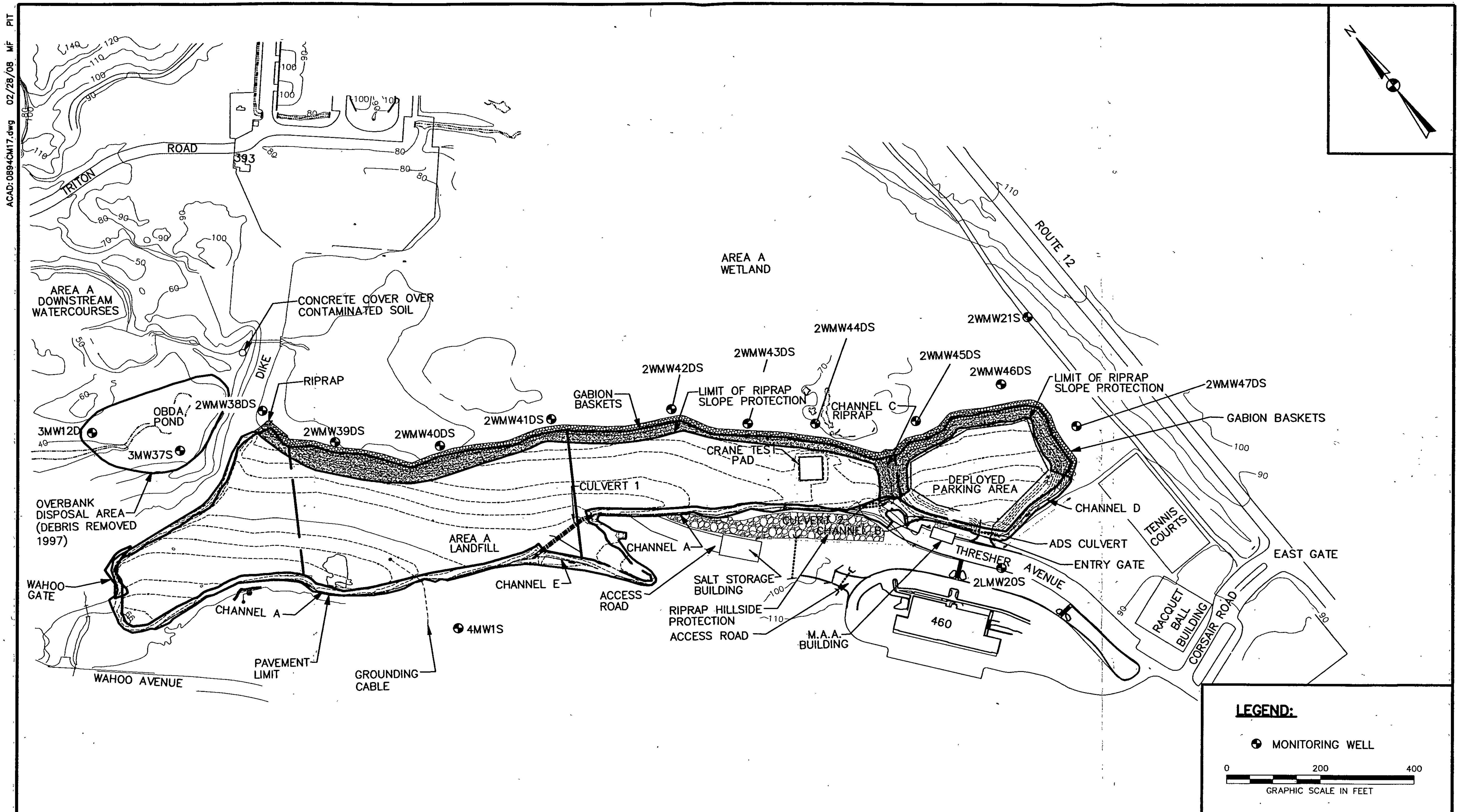
GRAPHIC SCALE IN FEET

DRAWN BY MF	DATE 2/28/08	Tetra Tech NUS, Inc.	SITE LOCATION MAP OPERABLE UNIT 9 - BASEWIDE GROUNDWATER RECORD OF DECISION NSB-NLON, GROTON, CONNECTICUT	CONTRACT NO. 0894	
CHECKED BY	DATE			OWNER NO. 0431	
REVISED BY	DATE			APPROVED BY *CAL*	DATE *2/29/08*
SCALE AS NOTED				DRAWING NO. FIGURE 2-2	REV. 0

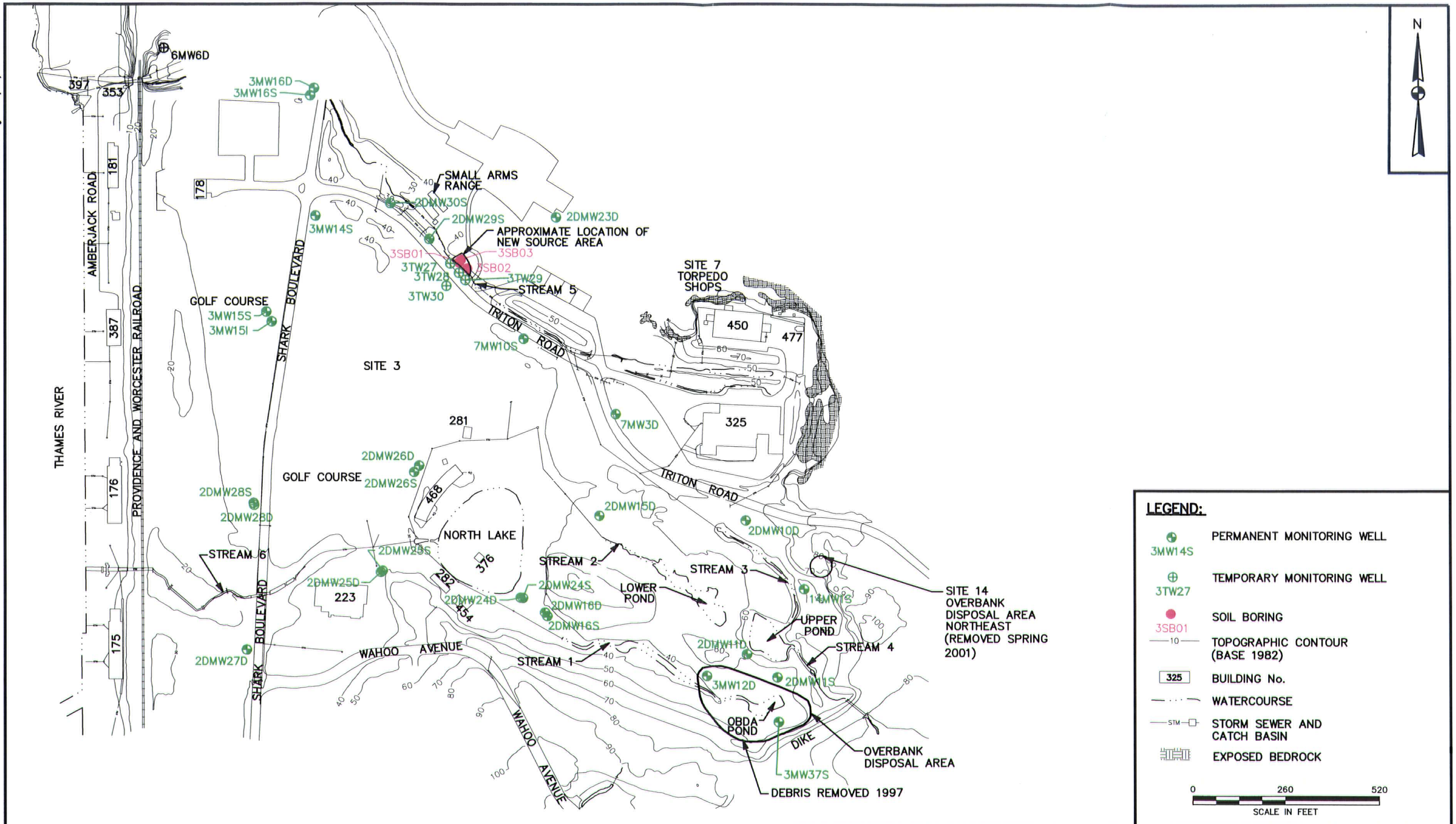


NOTE:

GROUNDWATER ANALYTICAL DATA FROM MONITORING REPORT FOR AREA A LANDFILL: YEAR 7 (ECC, 2007)

DRAWN BY MF — DATE 2/28/07	Tetra Tech NUS, Inc.	SITE 2 GENERAL SITE LAYOUT AND SAMPLE LOCATIONS OPERABLE UNIT 9 - BASEWIDE GROUNDWATER NSB-NLON, GROTON, CONNECTICUT	CONTRACT NO. 0894
CHECKED BY — DATE			OWNER NO. 0431
REVISED BY — DATE			APPROVED BY CAL — DATE 2/29/08
SCALE AS NOTED			DRAWING NO. FIGURE 2-3 — REV. 0

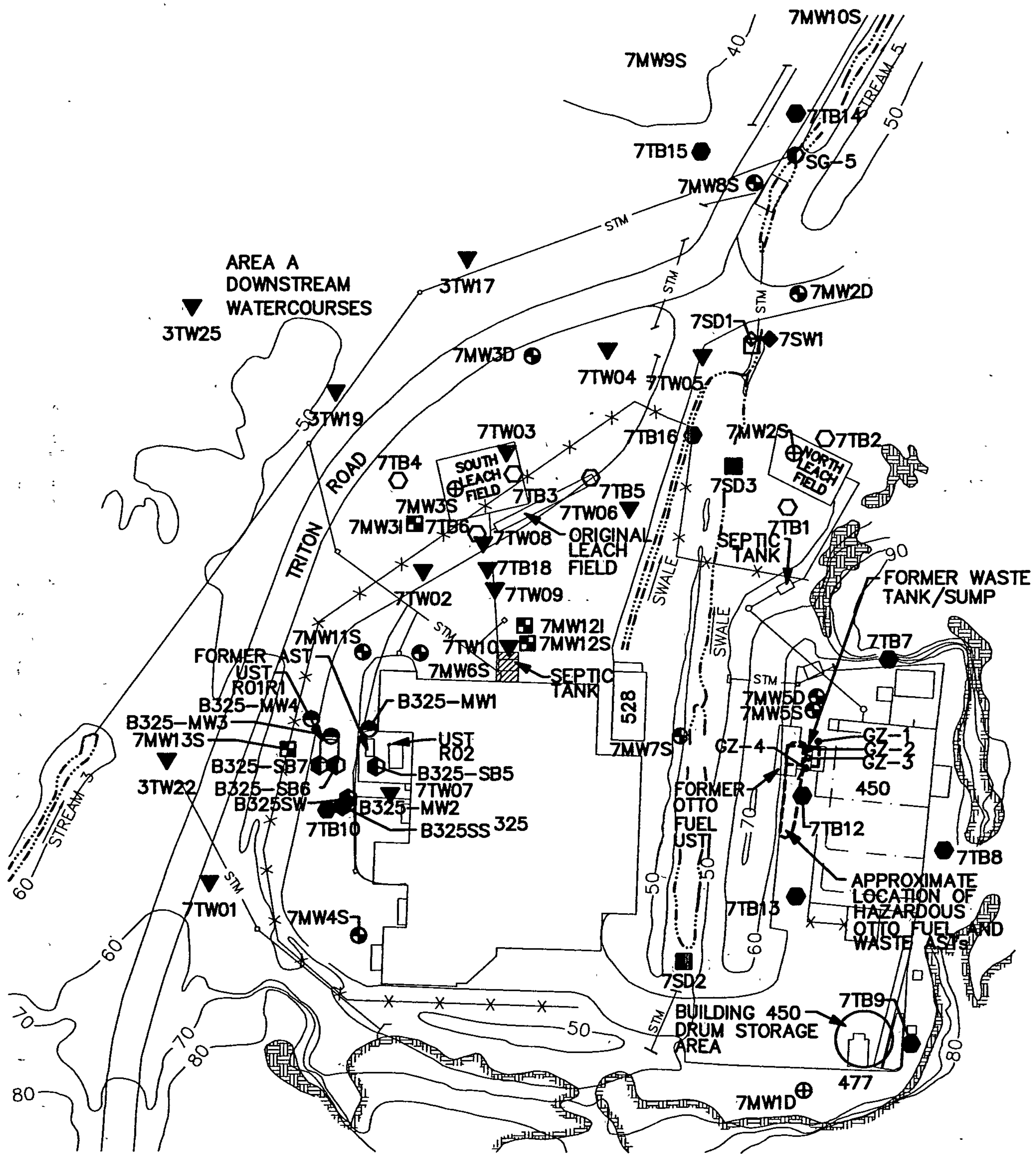
ACAD: 0894CM14.dwg 02/28/08 MF PIT



DRAWN BY MF	DATE 2/28/08	Tetra Tech NUS, Inc.	SITES 3 AND 14 GENERAL SITE LAYOUT AND SAMPLING LOCATIONS OPERABLE UNIT 9 - BASEWIDE GROUNDWATER RECORD OF DECISION NSB-NLON, GROTON, CONNECTICUT	CONTRACT NO. 0894	
CHECKED BY	DATE			OWNER NO. 0431	
REVISED BY	DATE			APPROVED BY CAL	DATE 2/29/08
SCALE AS NOTED				DRAWING NO. FIGURE 2-4	REV. 0

FORM CADD NO. TTNUS-BH.DWG – REV 1 – 9/10/98

ACAD: 0894CM23.dwg 02/29/08 MF PIT



NOTES

1. UNDERGROUND UTILITY LOCATIONS ARE APPROXIMATE.
2. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON AND PHASE II RI WORK PLAN.

LEGEND

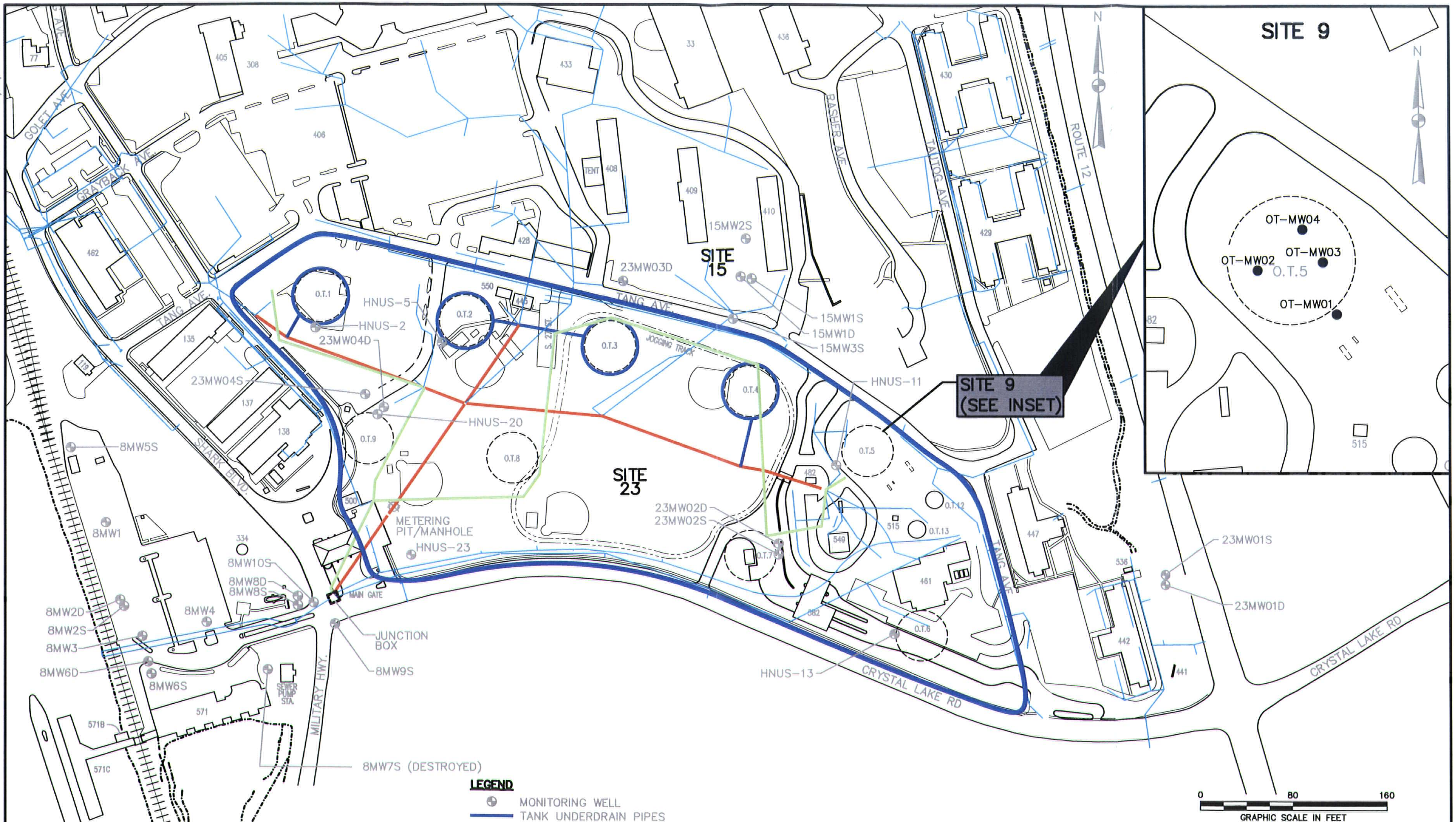
7MW13S	GROUNDWATER MONITORING PROGRAM WELL
7MW2S	PHASE I MONITORING WELL
7MW7S	PHASE II MONITORING WELL
B325-MW1	SITE CHARACTERIZATION MONITORING WELL
7TB1	PHASE I TEST BORING
7TB12	PHASE II TEST BORING
B325-SB6	SITE CHARACTERIZATION SOIL BORING
7SW1	PHASE I EXISTING SURFACE WATER SAMPLE
7SW1	PHASE II SURFACE WATER SAMPLE
7SD1	PHASE I SEDIMENT SAMPLE
7SD3	PHASE II SEDIMENT SAMPLE
SG-5	PHASE II STAFF GAUGE
7TB17	BGOURI TEST BORING LOCATION
7TW17	BGOURI TEMPORARY WELL
10	TOPOGRAPHIC CONTOUR
123	BUILDING No.
	WATERCOURSE
STM	STORM SEWER AND CATCH BASIN
	EXPOSED BEDROCK
	FENCE

0 110 220
SCALE IN FEET

DRAWN BY MF — DATE 2/29/08	Tetra Tech NUS, Inc.	SITE 7 GENERAL SITE LAYOUT AND SAMPLING LOCATIONS OPERABLE UNIT 9 - BASEWIDE GROUNDWATER RECORD OF DECISION NSB-NLON, GROTON, CONNECTICUT	CONTRACT NO. 0894	
CHECKED BY — DATE			OWNER NO. 0431	
REVISED BY — DATE			APPROVED BY CAN — DATE 2/29/08	
SCALE AS NOTED			DRAWING NO. FIGURE 2-5	REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

ACAD: 0894CM28.DWG 02/29/08 MF PIT



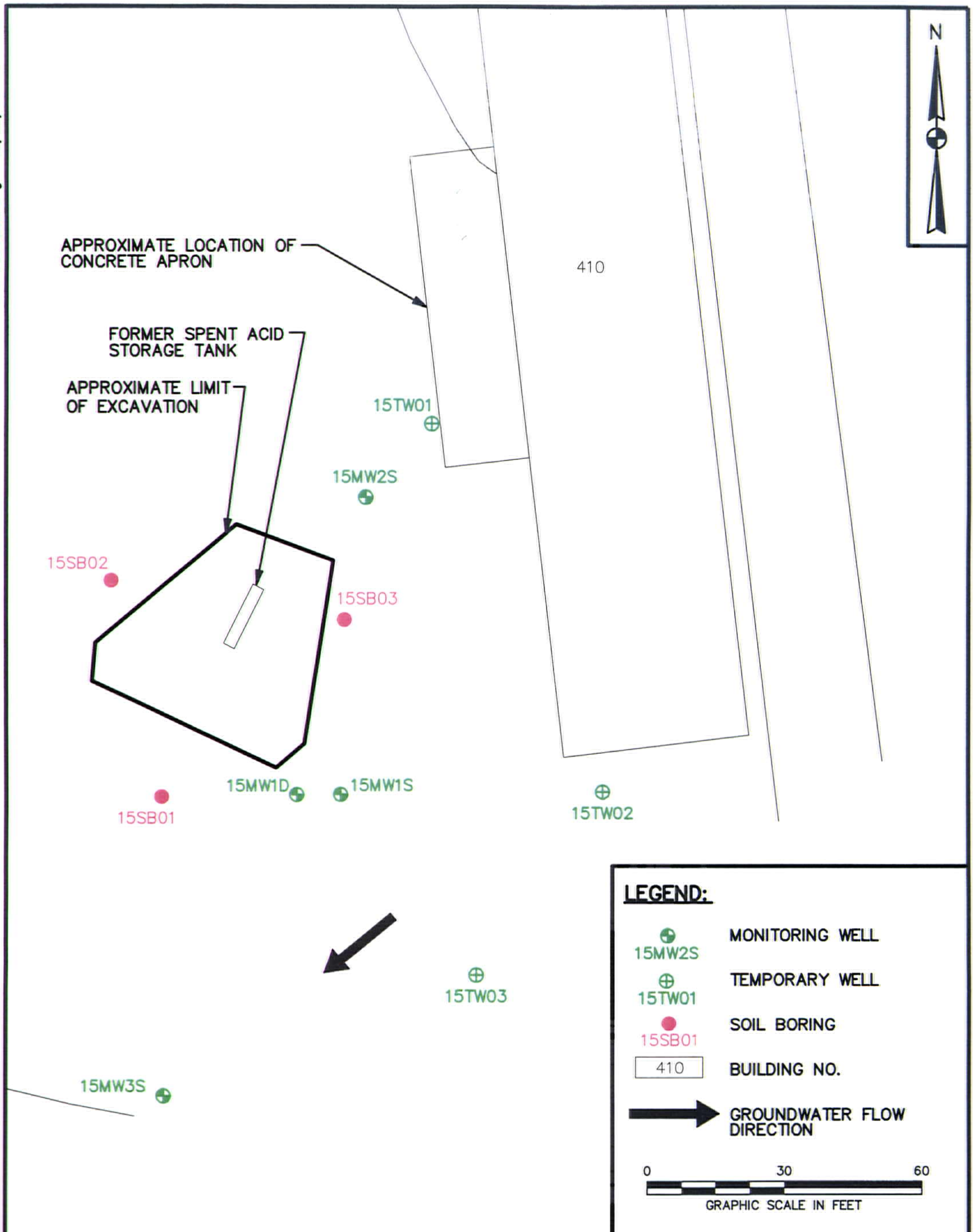
DRAWN BY MF	DATE 2/29/08
CHECKED BY	DATE
REVISED BY	DATE
SCALE AS NOTED	

Tetra Tech NUS, Inc.

SITES 9 & 23
GENERAL SITE LAYOUT
OPERABLE UNIT 9 –
BASEWIDE GROUNDWATER
NSB–NLON, GROTON, CONNECTICUT

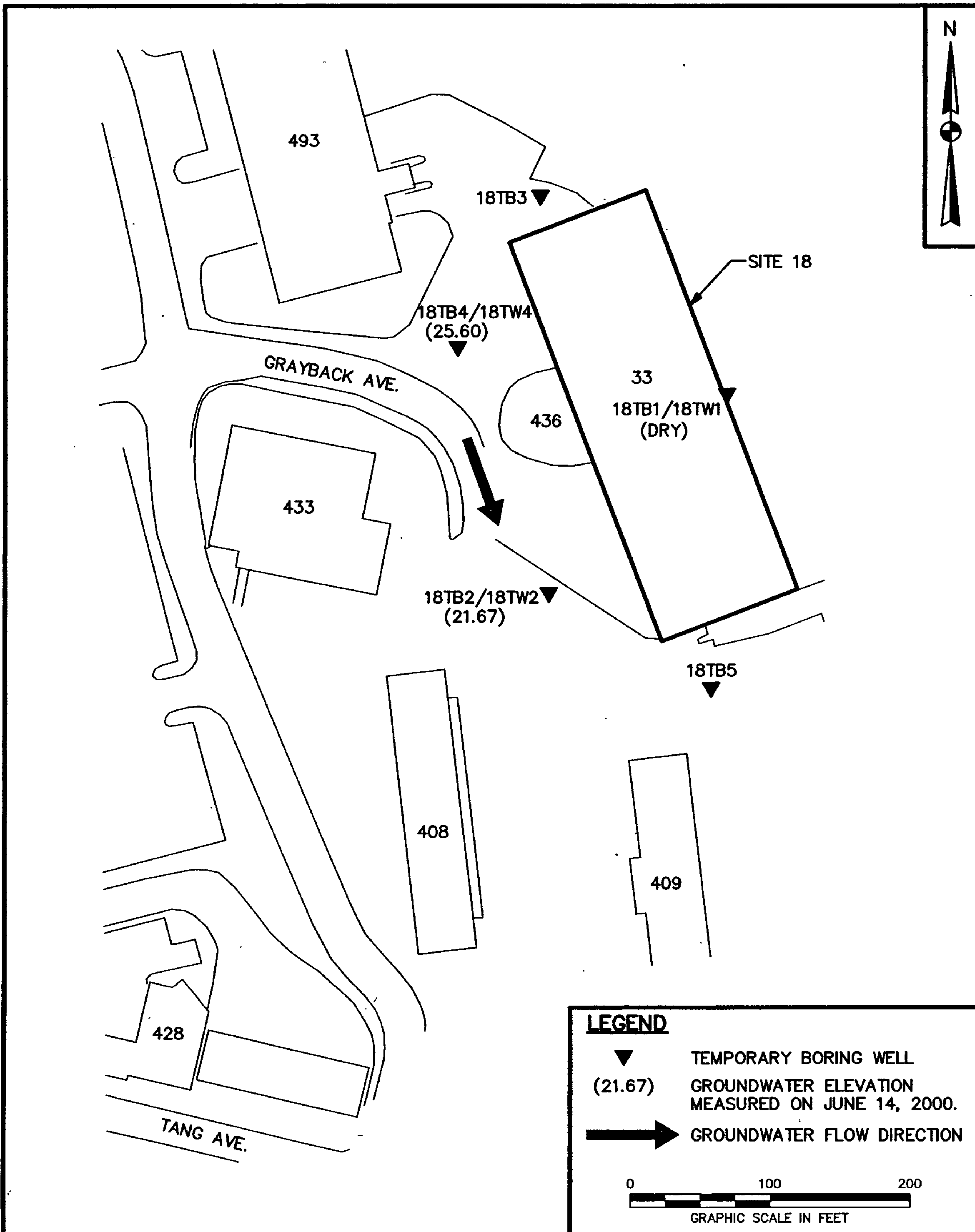
CONTRACT NO. 0894	
OWNER NO. 0431	
APPROVED BY	DATE
DRAWING NO. FIGURE 2–6	REV. 0

ACAD: 0894CM11.dwg 02/28/08 MF PIT



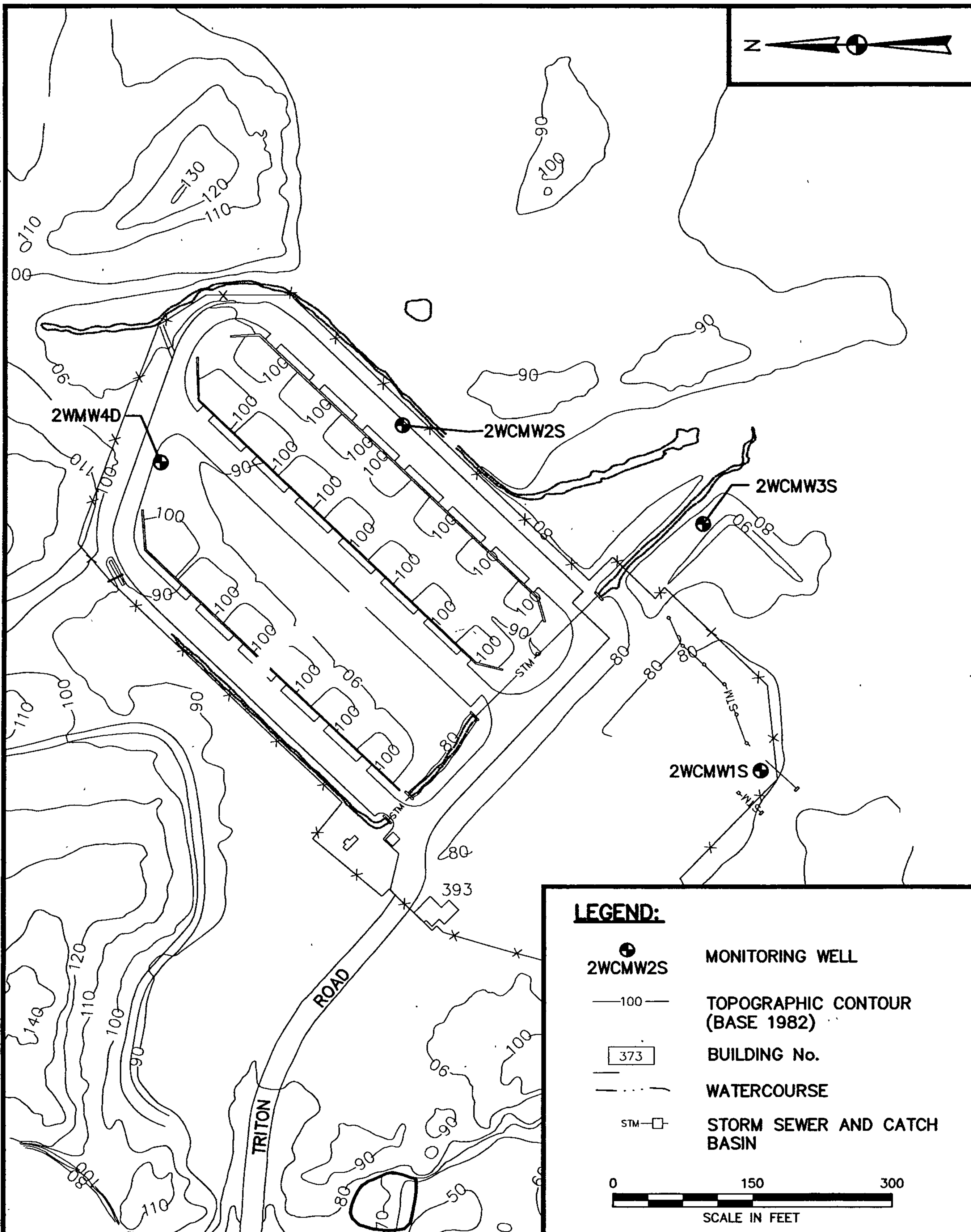
DRAWN BY MF	DATE 2/28//07	Tetra Tech NUS, Inc.	SITE 15 GENERAL LAYOUT AND SAMPLING LOCATIONS OPERABLE UNIT 9 - BASEWIDE GROUNDWATER NSB-NLON, GROTON, CONNECTICUT	CONTRACT NO. 0894	
CHECKED BY	DATE			OWNER NO. 0431	
REVISED BY	DATE			APPROVED BY CAL	DATE 2/29/08
SCALE AS NOTED				DRAWING NO. FIGURE 2-7	REV. 0

FORM CADD NO. TTNUS-AV.DWG – REV 1 –9/10/98



DRAWN BY	DATE			
MF	2/28/08	Tetra Tech NUS, Inc.	SITE 18 GENERAL LAYOUT AND SAMPLING LOCATIONS OPERABLE UNIT 9 - BASEWIDE GROUNDWATER NSB-NLON, GROTON, CONNECTICUT	CONTRACT NO. 0894
CHECKED BY	DATE			OWNER NO. 0431
REVISED BY	DATE			APPROVED BY CAR DATE 2/29/08
SCALE AS NOTED				DRAWING NO. FIGURE 2-8 REV. 0

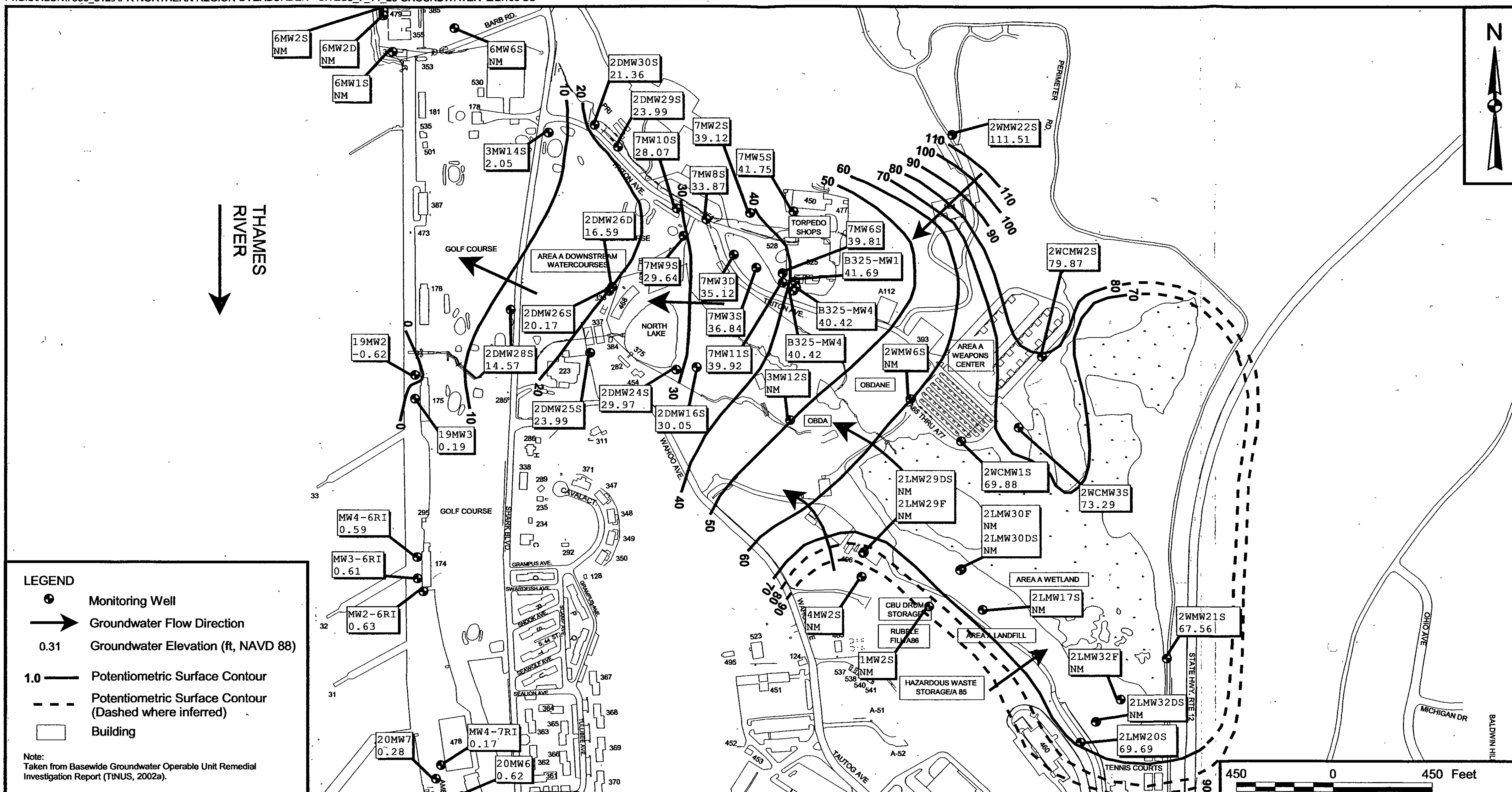
ACAD: 0894CM13.dwg 02/28/08 MF PIT



DRAWN BY MF	DATE 2/28/08	Tetra Tech NUS, Inc.	SITE 20 GENERAL SITE LAYOUT AND SAMPLING LOCATIONS OPERABLE UNIT 9 - BASEWIDE GROUNDWATER RECORD OF DECISION NSB-NLON, GROTON, CONNECTICUT	CONTRACT NO. 0894	
CHECKED BY	DATE			OWNER NO. 0431	
REVISED BY	DATE			APPROVED BY CAL	DATE 2/29/08
SCALE AS NOTED				DRAWING NO. FIGURE 2-9	REV. 0

FORM CADD NO. TTNUS-AV.DWG – REV 1 –9/10/98

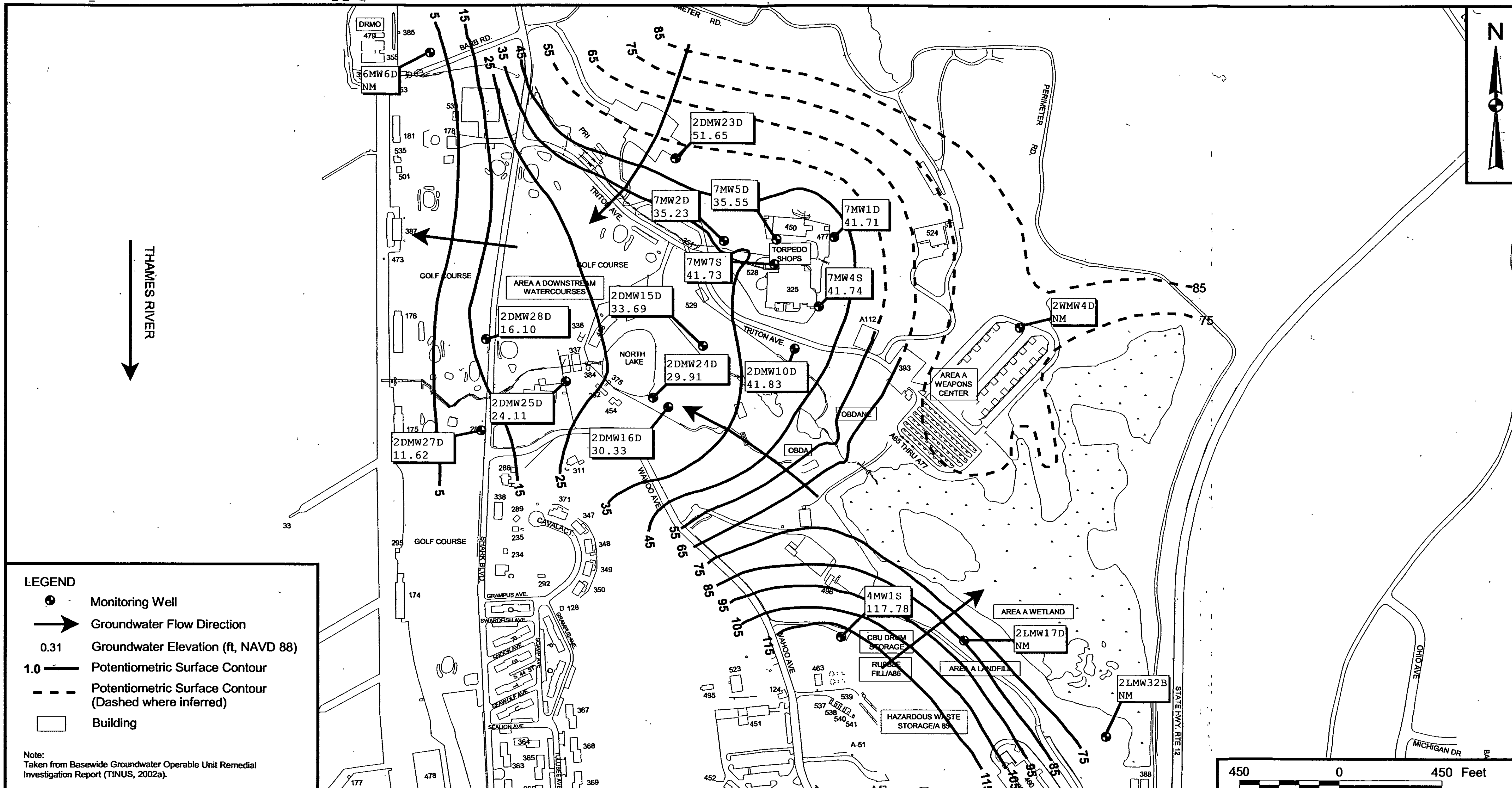
P:\GIS\NLON\7856_312.APR NORTHERN REGION OVERBURDEN - SITES3_7_14_20 GROUNDWATER 2/27/08 SS



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY / DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER 0894 / OWNER NUMBER 0431
CHECKED BY / DATE	SHALLOW OVERBURDEN POTENTIOMETRIC SURFACE MAP AUGUST 2000 NORTHERN REGION OPERABLE UNIT 9 - BASEWIDE GROUNDWATER RECORD OF DECISION NSB-NLON, GROTON, CONNECTICUT	APPROVED BY CAR / DATE 2/29/08
COST/SCHEDULE-AREA		APPROVED BY / DATE
SCALE AS NOTED		DRAWING NO. FIGURE 2-10 / REV 0

P:\GIS\NLON\7856_312.APR NORTHERN REGION BEDROCK - SITES3_7_14_20 GROUNDWATER 2/27/08 SS



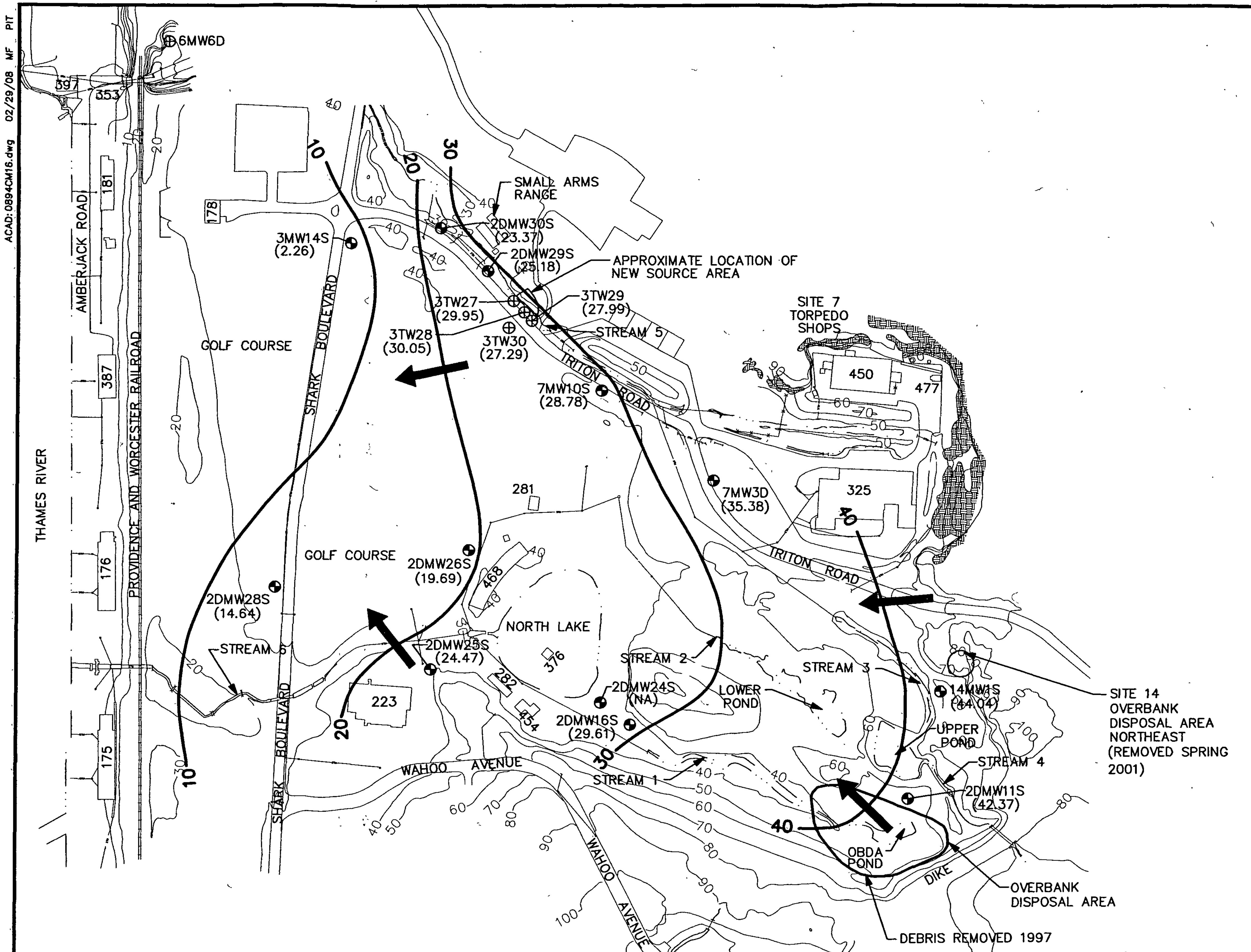
NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY — DATE
CHECKED BY — DATE
COST/SCHEDULE-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

BEDROCK POTENTIOMETRIC SURFACE MAP
AUGUST 2000
NORTHERN REGION
OPERABLE UNIT 9 - BASEWIDE GROUNDWATER
RECORD OF DECISION
NSB-NLON, GROTON, CONNECTICUT

CONTRACT NUMBER 0894
OWNER NUMBER 0431
APPROVED BY CAL DATE 2/29/08
APPROVED BY — DATE —
DRAWING NO. FIGURE 2-11
REV 0



LEGEND:

2DMW30S	PERMANENT MONITORING WELL
3TW27	TEMPORARY MONITORING WELL
40	POTENTIOMETRIC SURFACE CONTOUR OCTOBER 2002
(42.37)	GROUNDWATER ELEVATION (FT.) MEASURED 10-24-02 (VERTICAL DATUM IS NAVD 88)
	GROUNDWATER FLOW DIRECTION
—10—	TOPOGRAPHIC CONTOUR
123	BUILDING No.
	WATERCOURSE
—STM—□	STORM SEWER AND CATCH BASIN
	EXPOSED BEDROCK

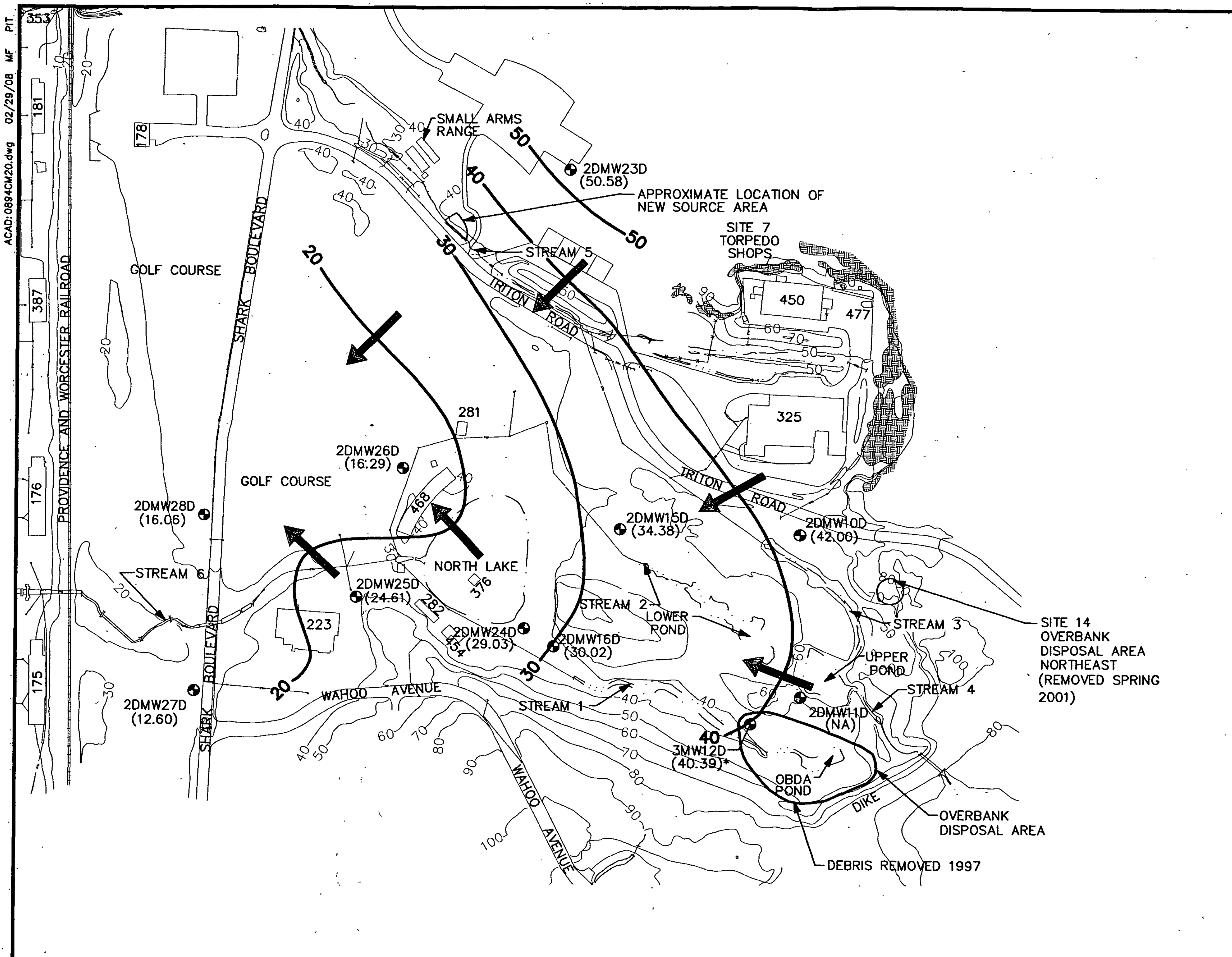
NOTE:

TAKEN FROM BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION UPDATE/FEASIBILITY STUDY (TtNUS, 2004).

0 250 500
SCALE IN FEET

DRAWN BY MF DATE 2/29/08	Tetra Tech NUS, Inc.	SHALLOW OVERBURDEN POTENTIOMETRIC SURFACE MAP FOR SITES 3 AND 14 - OCTOBER 2002 OPERABLE UNIT 9 - BASEWIDE GROUNDWATER RECORD OF DECISION NSB-NLON, GROTON, CONNECTICUT	CONTRACT NO. 0894
CHECKED BY DATE			OWNER NO. 0431
REVISED BY DATE			APPROVED BY CAL DATE 2/29/08
SCALE AS NOTED			DRAWING NO. FIGURE 2-12 REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98



LEGEND:

2DMW23D	PERMANENT MONITORING WELL
20	POTENTIOMETRIC SURFACE CONTOUR OCTOBER 2002
(30.02)	GROUNDWATER ELEVATION (FT.) MEASURED 10-24-02 (VERTICAL DATUM IS NAVD 88)
	GROUNDWATER FLOW DIRECTION
—10—	TOPOGRAPHIC CONTOUR
123	BUILDING No.
	WATERCOURSE
STM	STORM SEWER AND CATCH BASIN
	EXPOSED BEDROCK

NOTES:

1. * GROUNDWATER MONITORING WELL 3MW12D INSTALLED 10/24/02. GROUNDWATER ELEVATION MEASURED 12/04/02.
2. TAKEN FROM BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION UPDATE/FEASIBILTY STUDY (TtNUS, 2004).

0 250 500

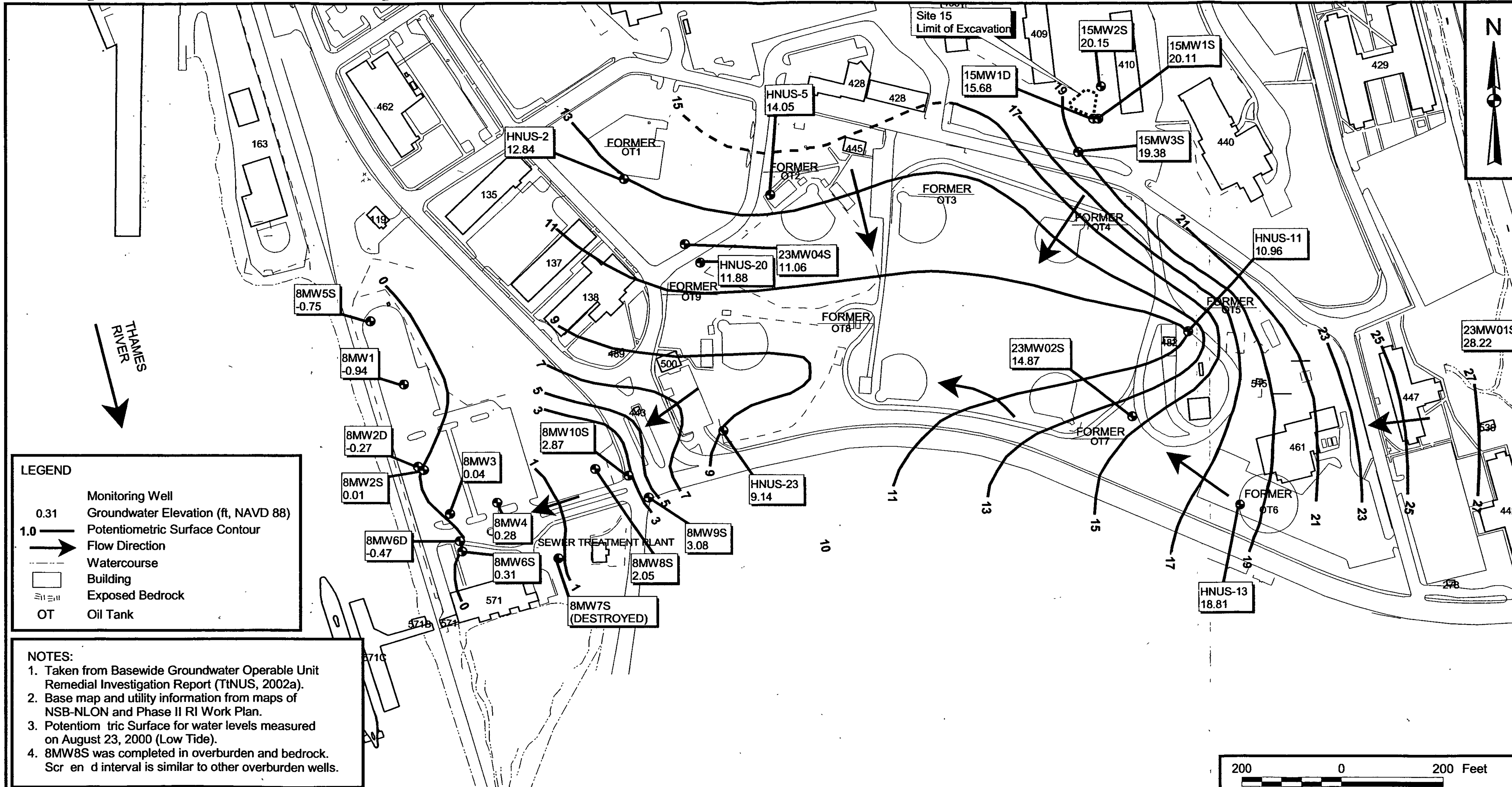
SCALE IN FEET

DRAWN BY MF	DATE 2/29/08	Tetra Tech NUS, Inc.	BEDROCK POTENTIOMETRIC SURFACE MAP FOR SITES 3 AND 14 - OCTOBER 2002 OPERABLE UNIT 9 - BASEWIDE GROUNDWATER RECORD OF DECISION NSB-NLON, GROTON, CONNECTICUT	CONTRACT NO. 0894
CHECKED BY	DATE			OWNER NO. 0431
REVISED BY	DATE			APPROVED BY CAR DATE 2/29/08
SCALE AS NOTED				DRAWING NO. FIGURE 2-13 REV. 0

ACAD: 0894CM20.dwg 02/29/08 MF PIT

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

P:\GIS\NLON\7856_312.APR TANK FARM OVERBURDEN - AUGUST 23 & 24, 2000_FIG2-6 2/27/08 SS



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

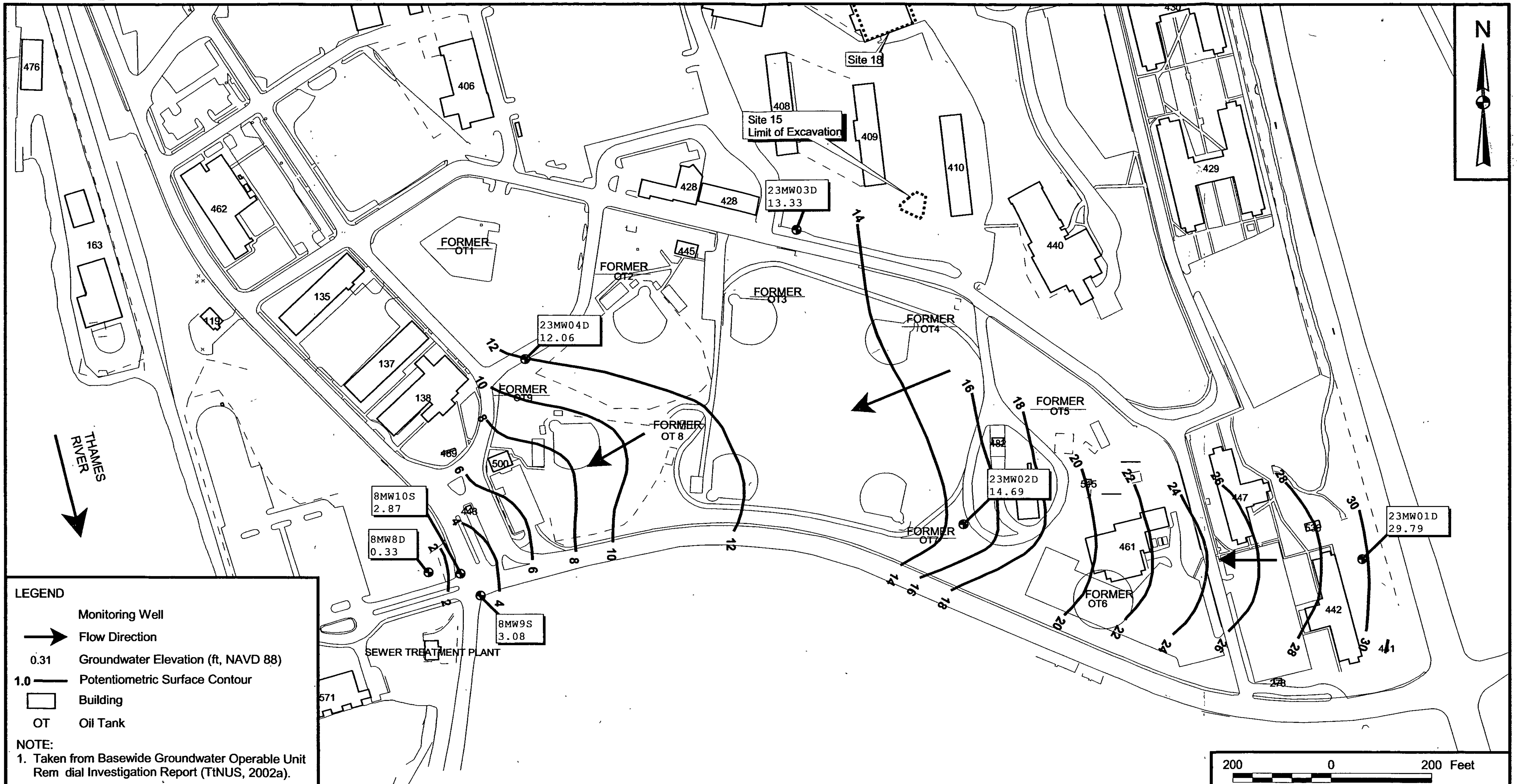
DRAWN BY — DATE
CHECKED BY — DATE
COST/SCHEDULE-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

SHALLOW OVERBURDEN POTENTIOMETRIC SURFACE MAP
AUGUST 2000
SOUTHERN REGION
OPERABLE UNIT 9 - BASEWIDE GROUNDWATER
RECORD OF DECISION
NSB-NLON, GROTON, CONNECTICUT

CONTRACT NUMBER	OWNER NUMBER
0894	0431
APPROVED BY CAL	DATE 2/29/08
APPROVED BY —	DATE —
DRAWING NO. FIGURE 2-14	REV 0

P:GIS\NLON\7856_312.APR TANK FARM BEDROCK-AUGUST 2000_FIG2-7 2/27/08 SS



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY — DATE

CHECKED BY — DATE

COST/SCHEDULE-AREA

SCALE: AS NOTED

Tetra Tech NUS, Inc.

BEDROCK POTENTIOMETRIC SURFACE MAP
AUGUST 2000
SOUTHERN REGION
OPERABLE UNIT 9 - BASEWIDE GROUNDWATER
RECORD OF DECISION
NSB-NLON, GROTON, CONNECTICUT

CONTRACT NUMBER: 0894

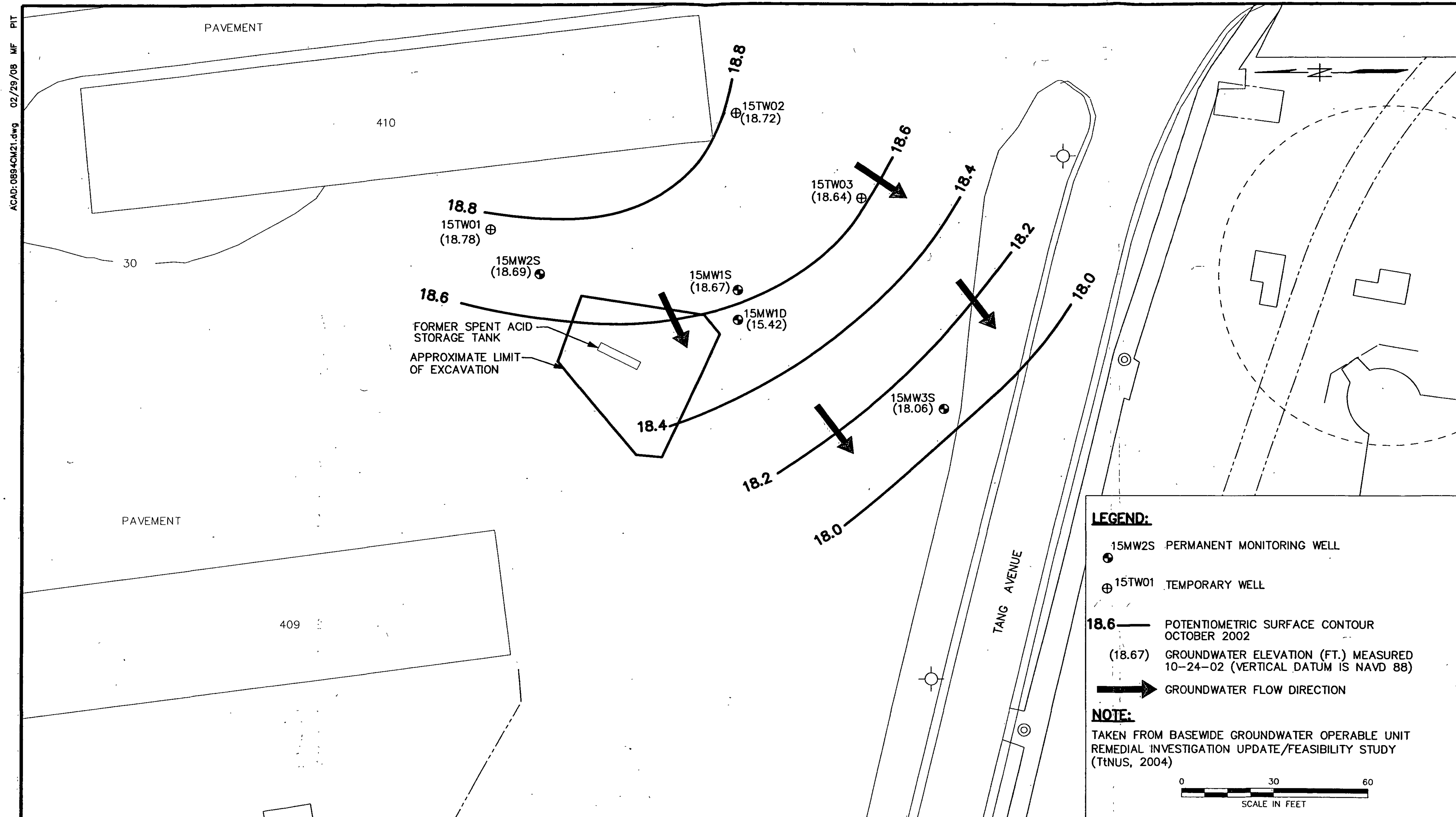
OWNER NUMBER: 0431

APPROVED BY: CAL — DATE: 2/29/08

APPROVED BY: — — DATE: —

DRAWING NO.: FIGURE 2-15

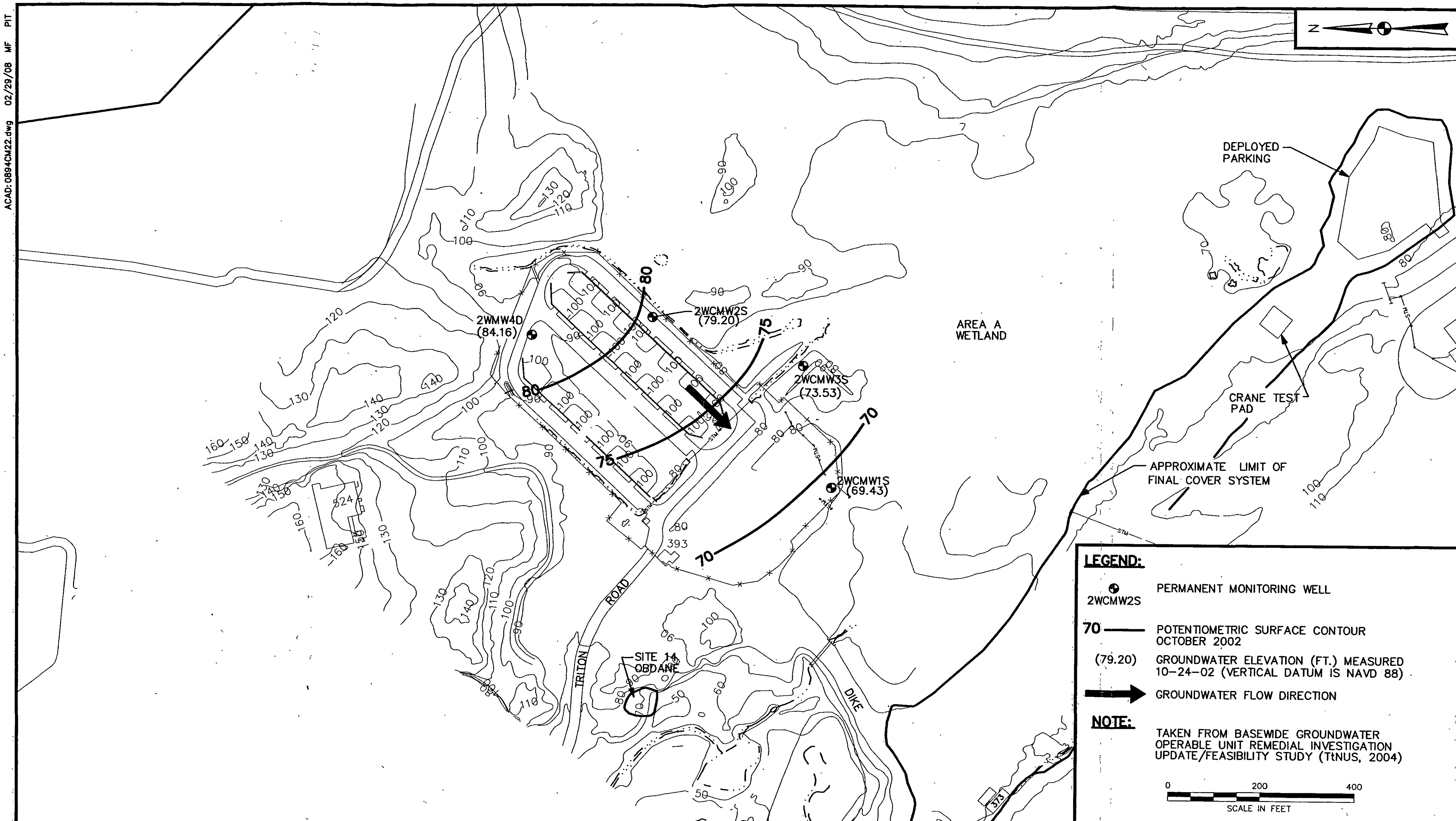
REV: 0



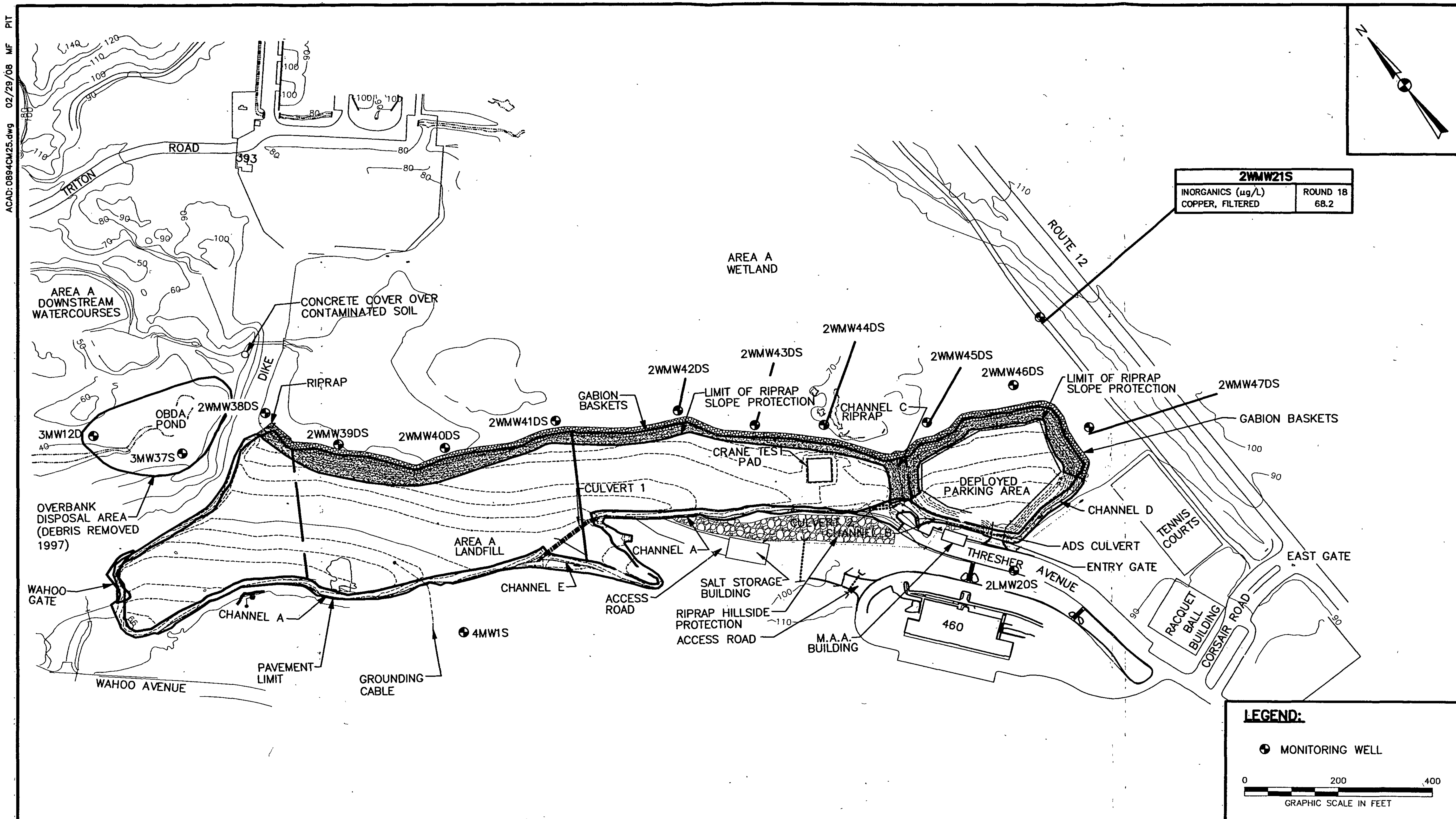
DRAWN BY MF	DATE 2/29/08		SITE 15 SHALLOW OVERBURDEN POTENTIOMETRIC SURFACE MAP OPERABLE UNIT 9 - BASEWIDE GROUNDWATER RECORD OF DECISION NSB-NLON, GROTON, CONNECTICUT	CONTRACT NO. 0894	
CHECKED BY	DATE	Tetra Tech NUS, Inc.		OWNER NO. 0431	
REVISED BY	DATE			APPROVED BY	DATE
SCALE AS NOTED				DRAWING NO. FIGURE 2-16	REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

ACAD: 0894CM22.dwg 02/29/08 MF PIT



DRAWN BY MF	DATE 2/29/08	Tetra Tech NUS, Inc.	SITE 20 SHALLOW OVERBURDEN POTENTIOMETRIC SURFACE MAP OPERABLE UNIT 9 - BASEWIDE GROUNDWATER RECORD OF DECISION NSB-NLON, GROTON, CONNECTICUT	CONTRACT NO. 0894
CHECKED BY	DATE			OWNER NO. 0431
REVISED BY	DATE			APPROVED BY CAL DATE 2/29/08
SCALE AS NOTED				DRAWING NO. FIGURE 2-17 REV. 0



NOTE:

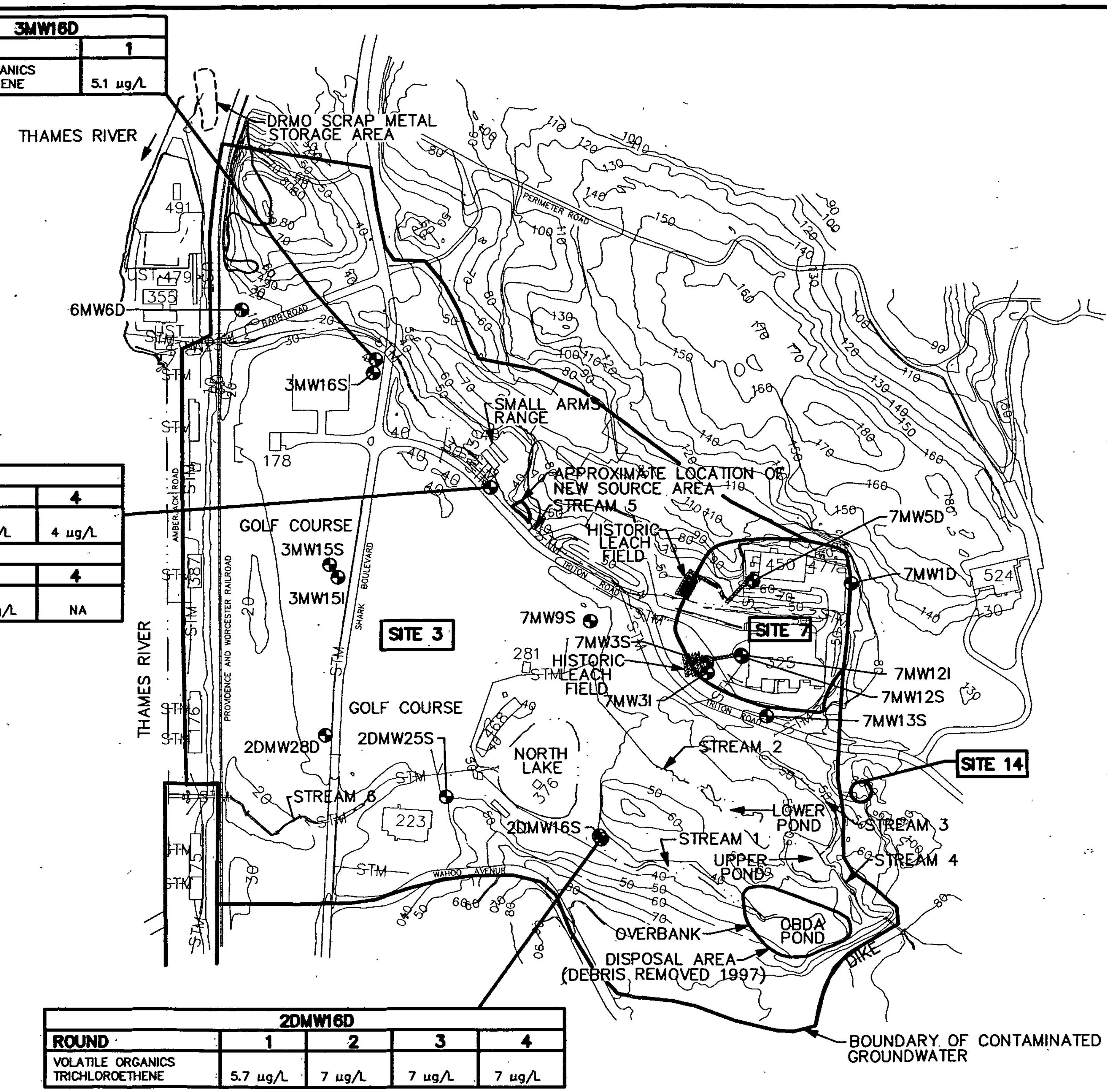
GROUNDWATER ANALYTICAL DATA FROM MONITORING REPORT FOR AREA A LANDFILL: YEAR 7 (ECC, 2007)

DRAWN BY MF	DATE 2/29/08
CHECKED BY	DATE
REVISED BY	DATE
SCALE AS NOTED	

Tetra Tech NUS, Inc.

SITE 2 YEAR 7 GROUNDWATER MONITORING EXCEEDANCES
OPERABLE UNIT 9 -
BASEWIDE GROUNDWATER
NSB-NLON, GROTON, CONNECTICUT

CONTRACT NO. 0894	
OWNER NO. 0431	
APPROVED BY CAL	DATE 2/29/08
DRAWING NO. FIGURE 2-18	REV. 0



3MW16D	
ROUND	1
VOLATILE ORGANICS TRICHLOROETHENE	5.1 µg/L

2DMW29S		
ROUND	2	4
VOLATILE ORGANICS VINYL CHLORIDE	9 µg/L	4 µg/L

2DMW29S DUP		
ROUND	2	4
VOLATILE ORGANICS VINYL CHLORIDE	10 µg/L	NA

2DMW16D				
ROUND	1	2	3	4
VOLATILE ORGANICS TRICHLOROETHENE	5.7 µg/L	7 µg/L	7 µg/L	7 µg/L

LEGEND:

NA NOT ANALYZED

MONITORING WELL

0 400 800
SCALE IN FEET

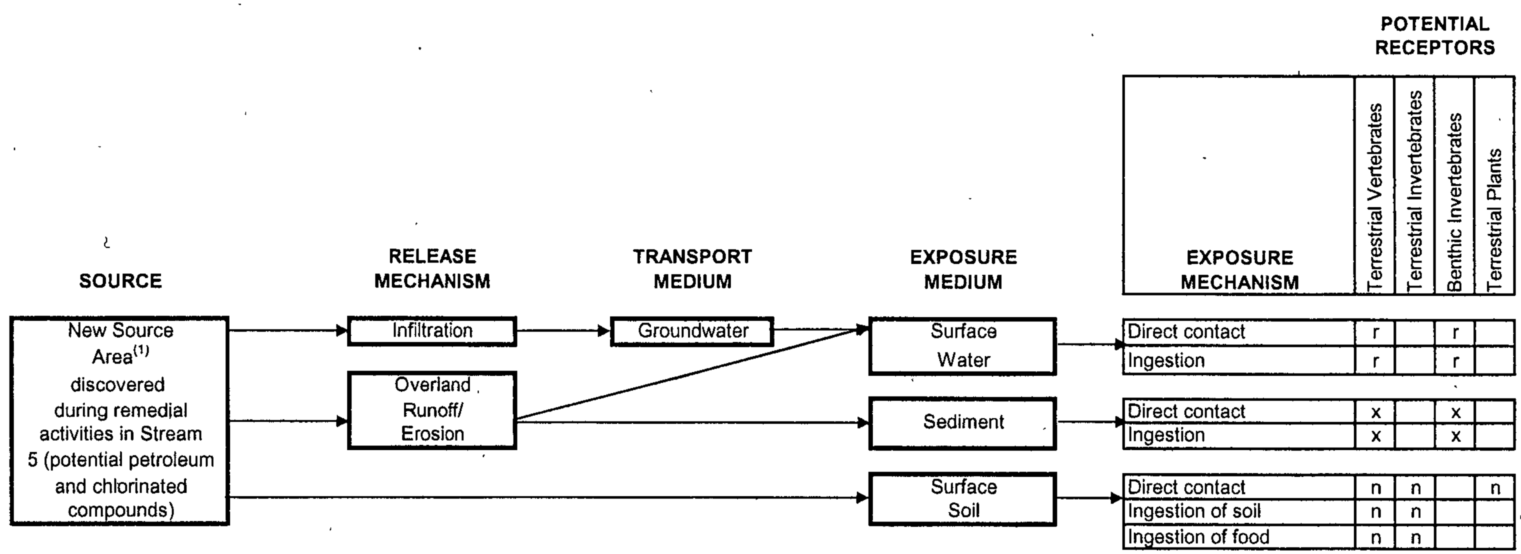
DRAWN BY MF / DATE 2/29/08	Tetra Tech NUS, Inc.	SITES 3 & 7 YEAR 1 GROUNDWATER MONITORING EXCEEDANCES OPERABLE UNIT 9 - BASEWIDE GROUNDWATER NSB-NLON, GROTON, CONNECTICUT	CONTRACT NO. 0894	
CHECKED BY / DATE			OWNER NO. 0431	
REVISED BY / DATE			APPROVED BY CAL / DATE 2/29/08	
SCALE AS NOTED			DRAWING NO. FIGURE 2-19	REV. 0

ACAD: TTNUS-BH.dwg 08/28/98 INL

FORM CADD NO. TTNUS-BH.DWG – REV 1 – 9/10/98

FIGURE 2-20

ECOLOGICAL CONCEPTUAL SITE MODEL FOR SITE 3 - NEW SOURCE AREA
OPERABLE UNIT 9 RECORD OF DECISION
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

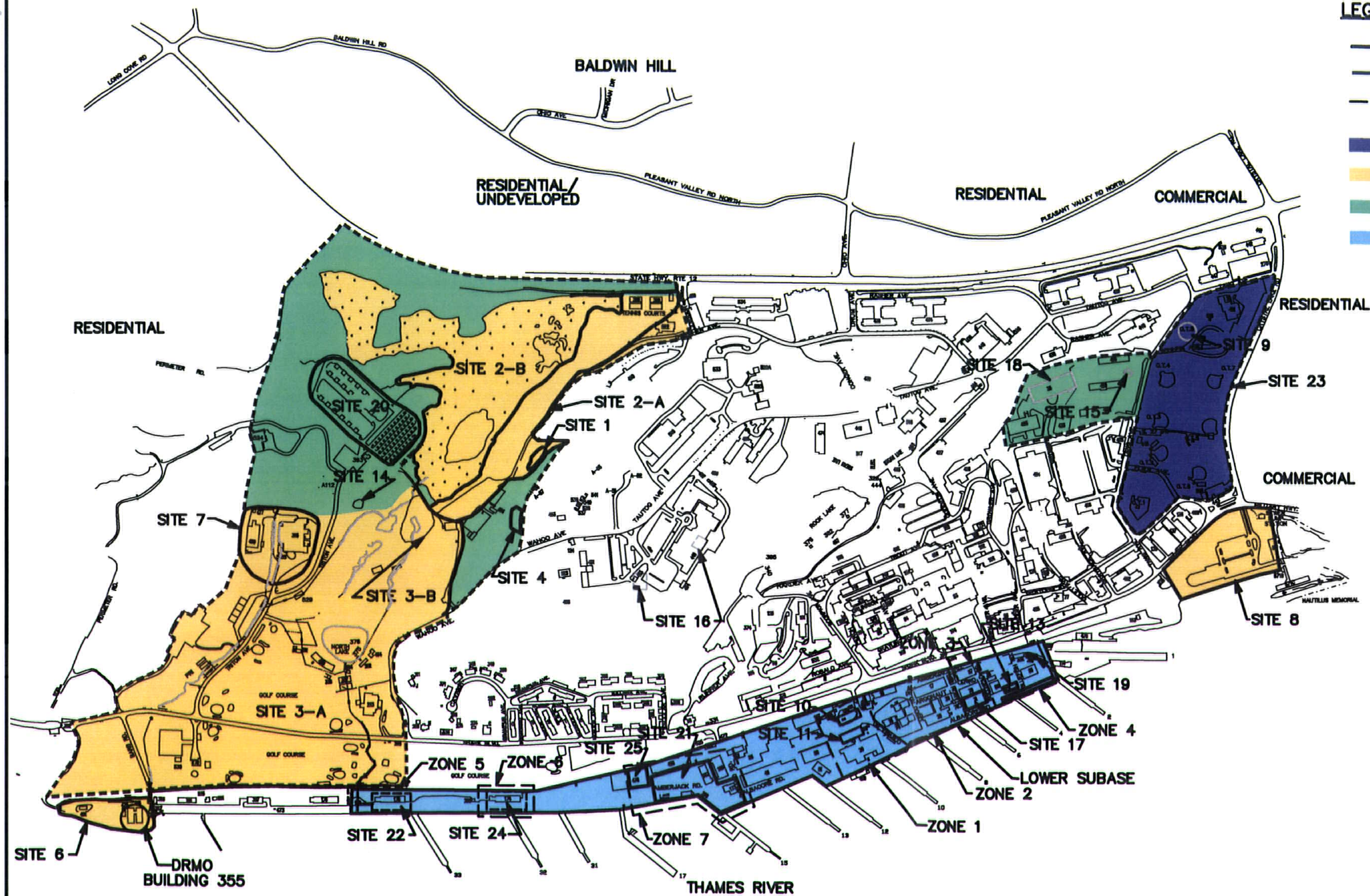


Exposure Medium	Exposure Mechanism	Terrestrial Vertebrates	Terrestrial Invertebrates	Benthic Invertebrates	Terrestrial Plants
Surface Water	Direct contact	r		r	
	Ingestion	r		r	
Sediment	Direct contact	x		x	
	Ingestion	x		x	
Surface Soil	Direct contact	n	n		n
	Ingestion of soil	n	n		
	Ingestion of food	n	n		

r = COMPLETE EXPOSURE PATHWAY; WILL BE EVALUATED INDIRECTLY BY COMPARING GROUNDWATER DATA TO SURFACE WATER SCREENING CRITERIA.
x = COMPLETE EXPOSURE PATHWAY, WILL BE EVALUATED INDIRECTLY BY COMPARING SURFACE SOIL DATA TO SEDIMENT SCREENING CRITERIA.
n = COMPLETE EXPOSURE PATHWAY, WILL BE EVALUATED DIRECTLY.

Blank space indicates incomplete exposure pathway or relatively insignificant, or not applicable potential exposure.

1 New Source Area located adjacent to Stream 5 in Site 3 - Area A Downstream Watercourses.



LEGEND:

- SITE BOUNDARY
- OU9 BOUNDARY
- LOWER SUBASE REMEDIAL INVESTIGATION ZONE BOUNDARY
- AREA WHERE GROUNDWATER LUCs WILL BE IMPLEMENTED
- AREA WITH GROUNDWATER LUCs
- AREA WITH NO GROUNDWATER LUC
- AREA WHERE GROUNDWATER LUCs ARE TBD IN A FUTURE ROD

LUC LAND USE CONTROL
TBD TO BE DETERMINED
ROD RECORD OF DECISION

SITE 1 – CONSTRUCTION BATTALION UNIT (CBU) DRUM STORAGE AREA
SITE 2 – (A) AREA A LANDFILL AND (B) AREA A WETLAND
SITE 3 – (A) AREA A DOWNSTREAM WATER COURSES AND (B) OVERBANK DISPOSAL AREA (OBDA)
SITE 4 – RUBBLE FILL AREA AT BUNKER A-86
SITE 6 – DEFENSE REUTILIZATION AND MARKETING OFFICE (DRMO)
SITE 7 – TORPEDO SHOPS
SITE 8 – GOSS COVE LANDFILL
SITE 9 – OILY WASTEWATER TANK (OT-5)
SITE 10 – LOWER SUBASE-FUEL STORAGE TANKS AND TANK 54-H
SITE 11 – LOWER SUBASE-POWER PLANT OIL TANKS
SITE 13 – LOWER SUBASE-BUILDING 79 WASTE OIL PIT
SITE 14 – OVERBANK DISPOSAL AREA NORTHEAST (OBDANE)
SITE 15 – SPENT ACID STORAGE AND DISPOSAL AREA (SASDA)
SITE 16 – HOSPITAL INCINERATORS
SITE 17 – HAZARDOUS MATERIALS/SOLVENT STORAGE AREA (BUILDING 31)
SITE 18 – SOLVENT STORAGE AREA (BUILDING 33)
SITE 19 – SOLVENT STORAGE AREA (BUILDING 36)
SITE 20 – AREA A WEAPONS CENTER
SITE 21 – BERTH 16
SITE 22 – PIER 33
SITE 23 – FUEL FARM
SITE 24 – CENTRAL PAINT ACCUMULATION AREA (BUILDING 174)
SITE 25 – LOWER SUBASE-CLASSIFIED MATERIALS INCINERATOR

NOTES:

1. SITE BOUNDRIES ARE APPROXIMATE
2. SOPA (ADMIN) NEW LONDON INSTRUCTION 5090.18C (2006) INCLUDES SITE USE RESTRICTIONS FOR AREAS WITH GROUNDWATER LUCs.

0 800 1600
SCALE IN FEET

DRAWN BY CK	DATE 7/07/08	Tetra Tech NUS, Inc.	AREAS WITH GROUNDWATER LAND USE CONTROLS OPERABLE UNIT 9 – BASEWIDE GROUNDWATER NSB–NLON, GROTON, CONNECTICUT	CONTRACT NO. 0894	
CHECKED BY	DATE			OWNER NO. 0431	
REVISED BY	DATE			APPROVED BY CAR	DATE 2/29/08
SCALE AS NOTED				DRAWING NO. FIGURE 2–21	REV. 0

ACAD: 0894CM05.dwg 07/07/08 CK PIT

3.0 RESPONSIVENESS SUMMARY

The Responsiveness Summary is a concise and complete summary of significant comments received from the public and includes responses to these comments. In addition, this summary provides decision makers with information about the views of the community. It also documents how the Navy, EPA, and CTDEP considered public comments during the decision-making process and provides answers to significant comments. In accordance with the guidance in Community Relations in Superfund: A Handbook (EPA, 1992), the Responsiveness Summary was prepared after the public comment period, which ended on July 14, 2008.

3.1 OVERVIEW

This ROD is for OU9, Basewide Groundwater, which includes the groundwater at Sites 2A, 2B, 3, 7, 9, 14, 15, 18, 20, and 23. The Proposed Plan, as presented to the public, identified Institutional Controls with Monitoring (Combination of Alternatives GW1-2 and GW2-2) as the Selected Remedy for Sites 3 and 7 groundwater, and Institutional Controls (Alternative GW3-2) as the Selected Remedy for Sites 9 and 23. The Selected Remedies are protective of human health and the environment, attain all ARARs, are considered by the Navy, EPA, and CTDEP as the alternatives that provided the best balance of the evaluation criteria. The Proposed Plan also identified NFA as the Selected Remedy for Sites 2, 14, 15, 18, and 20 groundwater. This remedy is appropriate because there are no unacceptable risks associated with exposure to groundwater at these sites. At Site 2, compliance monitoring of groundwater will continue to be conducted as part of the OU1 remedy.

3.2 BACKGROUND ON COMMUNITY INVOLVEMENT

The public comment period for the Proposed Plan for OU9 began on June 14, 2008, and ended on July 14, 2008. A public meeting was held on June 26, 2008, at the Best Western Olympic Inn on Route 12, Groton, Connecticut, to accept verbal comments on the proposed action. Comments on the proposed remedies were received during the public comment period, but none require revisions to be made to the Selected Remedies, as identified in the Proposed Plan.

3.3 SUMMARY OF COMMENTS RECEIVED DURING THE PUBLIC COMMENT PERIOD AND NAVY RESPONSES

Comments received during the June 26, 2008 Public Meeting are summarized below along with the Navy's responses. No other comments were received during the Public Comment Period which ended on July 14, 2008. None of the comments that were received impact the remedies selected by the Navy for the groundwater in OU9; therefore, no changes to the remedies are required in response to public comments.

Public Comment No. 1 (Mark Oefinger, Groton):

(a) Regarding Site 23, the old tank farm, were the sides and the bottom of the tanks left in place and filled with stone?

(b) The perimeter drains are being used because there is high ground water there, would it have been better to actually remove the drains? Are the perimeter drains needed because there's still contamination in the cement or in the tanks?

(c) Groundwater is being monitored because there is the potential for pollution, or was all pollution previously addressed?

Responses:

(a) Yes. The sides and the bottom of the tanks were left in place and filled with stone.

(b) The ring drains are primarily there because there is a continued need to dewater the site. Dewatering is required because it would flood out what used to be Crystal Lake approximately 50 to 60 years ago and because it may cause some of the tank carcasses to float to the surface. There is no contamination present in the cement of the tanks. All material was removed from the tanks prior to closure.

(c) There is some remnant oil contamination in the soil. The tanks were previously used to store Bunker Fuel (No. 6 Fuel Oil) and No. 2 Heating Oil. The one exception to that was one of the tanks was converted over to storing waste oils (OT-5). Removal actions were previously conducted by the Navy to address a majority of the oil contamination. Residual oil contamination is being addressed through natural attenuation (i.e., the breakdown/degradation of the oil over time). The monitoring provides the means to confirm that the oil is not migrating to the deep drain system which eventually discharges to the storm water system and the Thames River.

Public Comment No. 2 (Felix Prokopf, Ledge Light Health District):

(a) The Ledge Light Health District covers five towns including Ledyard, Town of Groton/City of Groton, Waterford, New London, and East Lyme and there are a lot of board members within those towns that would appreciate a two- or three-page summary of the Navy's activities. There is too much detail in the current documents for them to review. In addition, board members change every two or three years (e.g., there's new elections for the health district board) and this type of document would be useful for the new members. The document would provide a quick overview of what is going on and where they can get additional information such as at the library. Points-of-contact should also be included in the document. I could hand out this type of brochure if I get calls for information from another town.

(b) I have been coming to these meetings for many years and feel the Navy is doing a terrific job. Previously, the RAB Co-Chairman for the Public had a phone chain that was used to notify all RAB members prior to the meetings. Even after notification, very few officials showed up at the meetings. So there was a good system in place to communicate with members. I do not think the call system is being used anymore. Even though there was little interest in the past, maybe the Navy could improve its community outreach program to see if there is any new interest.

Responses:

(a) The Navy will prepare and provide you with a brief brochure that gives a general snapshot of the entire Installation Restoration Program. The EPA also noted that their website for the base has a two page summary of the progress at all of the sites at Naval Submarine Base - New London. The Navy will include the link to the EPA's website in the brochure.

(b) There was more interest in the environmental program in the past. As the various programs have matured, public interest has faded. As the Navy gets towards the end of the Installation Restoration Program, it is appropriate to reinitiate its community outreach program to make sure that people are aware that the end of the program is coming and things will be closed out soon. The Navy has taken or will take the following steps to improve its community outreach program: (1) The Navy added the Town Managers for the Towns of Groton and Ledyard to its distribution list in addition to the Mayors of those towns, (2) The EPA's Community Outreach Coordinator will be notified to determine if additional efforts are needed to inform the public about the Installation Restoration Program, and (3) the brochure discussed above will be prepared and issued.

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APPENDIX A

STATE OF CONNECTICUT
CONCURRENCE LETTER

STATE OF CONNECTICUT

DEPARTMENT OF ENVIRONMENTAL PROTECTION

79 ELM STREET HARTFORD, CT 06106-5127

PHONE: 860-424-3001

Gina McCarthy
Commissioner

September 30, 2008

James T. Owens, III, Director,
U.S. Environmental Protection Agency
Office of Site Remediation and Restoration
1 Congress St.
Suite 1100 (HIO)
Boston, MA 02114-2023

Mark S. Ginda
Captain, USN
Commanding Officer
Naval Submarine Base New London
Box 00, Building 86
Crystal Lake Road
Groton, CT 06349

Re: State Concurrence with Remedy for Operable Unit 9, Basewide Groundwater at Naval Submarine Base New London, Groton, Connecticut

Dear Mr. Owens and Captain Ginda:

The Connecticut Department of Environmental Protection (CTDEP) conditionally concurs with the final remedy selected by the EPA and the Navy for addressing basewide groundwater at the Naval Submarine Base New London, in Groton, Connecticut. The basewide groundwater is also known collectively as Operable Unit 9. This operable unit includes groundwater at 10 separate sites throughout the base.

The Navy proposes to address groundwater contaminants at the Area A Downstream Watercourses and Overbank Disposal Area (Site 3), and the Torpedo Shops (Site 7) by the continued use of institutional controls and groundwater monitoring. The institutional controls that were previously put in place include restrictions against the use of groundwater at all these sites and against residential use at Sites 2A, 2B, and 3. A new institutional control will be put in place at Site 3 to control potential exposure of future residents to soil vapor.

The Navy proposes to address groundwater at Waste Oil Tank 5 (Site 9) and the Tank Farm (Site 23) by implementing new institutional controls that would restrict the use of ground water.

The Navy will take no further action to address groundwater at the Area A Landfill (Site 2A), the Area A Wetland (Site 2B), Overbank Disposal Area Northeast (OBDANE, Site 14), the Spent Acid Storage and Disposal Area (Site 15), the Solvent Storage Area (Site 18, Building 33), and the Area A Weapons Center (Site 20). No groundwater contamination remains at these sites at concentrations in excess of Federal or state standards.

Groundwater at Sites 2, 3, 7, 14, 15, 18 and 20 was previously addressed in an interim remedy that the Navy implemented in 2004. The 2008 record of decision for Operable Unit 9 is the Navy's final selection of a remedy for groundwater at these sites.

The final remedies for groundwater at the Defense Reutilization and Marketing Office and the Goss Cove Landfill were included as part of source control remedies already selected for these sites. Groundwater at the Lower Base will be implemented as part of the source control remedy that will be selected for that site.

The remedy is described in detail in the proposed plan dated June 2008, and in the Record of Decision (ROD), dated July 2008.

The institutional controls will be memorialized in the base instruction document entitled "NSB-NLON Installation Restoration Site Use Restrictions Instruction document (5090.18C)". This document will remain in effect as long as the Navy continues to own the base. The ROD states that if the Navy sells or transfers the base, and contaminated groundwater remains at any of the sites, environmental land use restrictions (ELURs) will be recorded in accordance with state law.

The State's concurrence is conditioned upon the Navy making best efforts to comply with the requirements of the State's Remediation Standard Regulations regarding the recording of an environmental land use restriction to prohibit construction of a building at Site 3 on a schedule to be determined. The State expects that the Navy will propose a schedule to be agreed to by EPA, the Navy and the State.

Thank you for your cooperation on this project. DEP looks forward to working with the Navy and the US Environmental Protection Agency toward continued remediation at the Naval Submarine Base.

Yours truly,

Gina McCarthy
Commissioner

GM:MRL

C: Mr. Ron Pinkoski
Naval Facilities Engineering Command, Mid- Atlantic
9742 Maryland Avenue
Bldg N-26, Room 3208 (Code EV3)
Norfolk, VA 23511-3095

Ms. Kymberlee Keckler, Remedial Project Manager
US Environmental Protection Agency- Region 1
1 Congress St.
Suite 1100 (HBT)
Boston, MA 02114-2023

Naval Submarine Base New London
Attn: Richard Conant
Building 439, Room 105, Box 39
Crystal Lake Road
Groton, CT 06349

APPENDIX B

SOPA (ADMIN) NEW LONDON INSTRUCTION 5090.18D

DEPARTMENT OF THE NAVY

NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT 06349-5000

SOPA(ADMIN)NLONINST 5090.18D
9 Sep 08

SOPA (ADMIN) NEW LONDON INSTRUCTION 5090.18D

From: Commanding Officer, Naval Submarine Base New London

Subj: INSTALLATION RESTORATION SITE USE RESTRICTIONS AT NAVAL SUBMARINE BASE NEW LONDON, GROTON, CONNECTICUT

Ref:
(a) Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA)
(b) Superfund Amendments and Reauthorization Act of 1986 (SARA)
(c) Operational Naval Instruction (OPNAVINST) 5090.1B, Current Version
(d) Resource Conservation and Recovery Act (RCRA)
(e) Connecticut Department of Environmental Protection Remediation Standard Regulations
(f) Federal Facility Agreement under CERCLA 120, In the matter of the US Department of the Navy, Naval Submarine Base New London, Groton, Connecticut, January, 1995, and as amended.
(g) Record of Decision, Source Control Operable Unit, Area A landfill, Naval Submarine Base New London, Groton, Connecticut, September, 1995
(h) Record of Decision for Site 8 - Goss Cove Landfill, Soil and Sediment, Naval Submarine Base New London, Groton, Connecticut, February, 1998
(i) Record of Decision for Base-wide Groundwater Operable Unit 9, Naval Submarine Base, New London, Groton, Connecticut, September, 2008
(j) Public Works Department Instruction 11000.1A
(k) Record of Decision for Site 6 - Defense Reutilization and Marketing Office - Operable Unit 2, Naval Submarine Base - New London, Connecticut, December, 2006
(l) Operations and Maintenance Manual for Installation Restoration Program Sites at Naval Submarine Base New London, Groton, Connecticut, Volumes I, II, III, IV, and IV, January, 2006
(m) Draft Lower Subase Feasibility Study, Naval Submarine Base - New London, Groton, Connecticut, March, 2008
(n) Area A Landfill Allowable Loading Pressure, Naval Submarine Base New London, November, 2006

Encl:
(1) Defense Reutilization and Marketing Office (DRMO) Installation Restoration Site and Landfill Cap - Site 6
(2) Area A Landfill Installation Restoration Site and Landfill Cap - Site 2A

(3) Installation Restoration Site Map for Naval Submarine Base New London
(4) Excavated Soil Management for Installation Restoration sites at Naval Submarine Base New London
(5) Management of Dewatering Wastewaters for Installation Restoration Sites at Naval Submarine Base New London
(6) Goss Cove Landfill Installation Restoration Site and Landfill Cap - Site 8
(7) Monitoring Well Inventory Map

1. Purpose. This instruction defines the Naval Submarine Base New London (SUBASENLON) policy regarding ground surface disturbance of soils/sediments or any subsurface disturbance of soils/sediments and/or groundwater exposure or extraction in Installation Restoration (IR) sites and the disturbance of any remedial infrastructure, including monitoring wells and landfill waste caps. Disturbance is defined as any form of damage to remedial infrastructure, excavation, soil penetration, soil compaction, filling, or change of topography. The definition of disturbance also includes any proposed action to dewater excavations or extract/expose groundwater for discharge, consumption, or use in any way. This instruction is intended to enact institutional controls that are specified in references (a) through (n).

2. Cancellation. SOPA(ADMIN)NLONINST 5090.18C.

3. Applicability. This instruction is applicable to all Navy departments, tenant commands, contractors, invitees, and personnel at SUBASENLON.

4. Discussion. In accordance with references (a) through (n), the SUBASENLON IR Program manages the identification, characterization, and cleanup of contaminated soils, sediments and groundwater at specific SUBASENLON IR locations. The existing IR sites at SUBASENLON are in various stages of the IR investigation and cleanup process. Specialized landfill caps have been installed over the former landfill at the Defense Reutilization and Marketing Office (DRMO) site, see reference (k); the former landfill at the Area A site, see reference (g); the former Goss Cove landfill, see reference (h); and a small area of Area A Downstream, see enclosure (3) in order to isolate contaminated soils and sediments from the surrounding environment. These caps can be damaged by the operation or storage of heavy equipment on the cap surface or by unauthorized excavation or penetration through the cap surface. Enclosures (1), (2), (3), and (6) outline the extent of the former landfill sites, the current landfill caps, and the contamination at Area A Downstream. Enclosure (3) depicts the boundaries of all other identified IR sites at SUBASENLON and areas where groundwater use controls and restrictions are in effect. Groundwater and surface water shall not be extracted and used for any purpose at

SUBASENLON. Note that potential localized risk exists in Site 3 which could result from exposure to chemicals that could volatilize from groundwater and migrate through building foundations into indoor air. All proposed building projects in Site 3 must be coordinated through the SUBASENLON IR program manager to ensure that the building design process considers the potential issue of vapor intrusion and appropriate remedial strategies. All areas indicated in Enclosures (1), (2), (3) and (6) may contain contaminated soil, sediment or groundwater, which can potentially threaten human health or the environment if disturbed by unauthorized excavation or dewatering. Work can be safely conducted within the boundaries of identified IR sites, but proper planning, coordination, preparation, and safety measures must be implemented in accordance with federal and state laws. IR site work requires strict adherence to a site-specific health and safety plan, proper training of site workers, correct use of personal protective equipment by site workers, and proper management of any generated waste. Enclosures (4) and (5) provide guidance for excavation and dewatering in IR sites at SUBASENLON. Reference (l) provides requirements and guidance for the protection and maintenance of all IR sites identified in enclosure (3) and their associated structures, e.g., landfill cap asphalt wearing surfaces, landfill cap toe-slope protection, diversion channels, gas management vents, stormwater conveyances, material handling and storage pads, monitoring wells, and site perimeter fencing. Note that monitoring wells are not exclusively situated within the boundaries of the IR sites depicted in enclosure (3). Enclosure (7) provides the map of all known active, inactive and abandoned monitoring wells at SUBASENLON. All such structures shall not be modified, disturbed, or in any way affected without coordination with the SUBASENLON Public Works Environmental Division. The periodic and routine maintenance of all IR sites, and their associated structures, will be accomplished in strict adherence to reference (l) by authorized Navy contractors. The operation of equipment and storage of materials within any IR site identified in enclosure (3) shall also be in compliance with references (l) and (n).

5. Action. Prior to the operation or storage of any heavy equipment at the sites depicted in enclosures (1) and (6), all SUBASENLON departments, tenant commands, Navy contractors, and personnel shall contact SUBASENLON Public Works Planning and Environmental Divisions, which will determine general landfill cap loading restrictions for all equipment/materials to be operated or stationed on these landfill caps. The Area A Landfill Installation Restoration Site and Landfill Cap - Site 2A depicted in enclosure (2) is a restricted area controlled by SUBASE Chief Master-at-Arms (CMAA). All requests for access to Area A and for the storage of any heavy equipment/materials

at Area A will be referred to the CMAA office. The CMAA office will coordinate all heavy equipment/materials storage requests with the SUBASENLON Public Works Planning and Environmental Divisions prior to authorizing any storage of heavy equipment/materials at the site. The loading guidance provided in enclosure (n) shall be utilized to assess storage of heavy equipment/material on the Area A landfill cap site. Precaution must be taken to ensure that any equipment operated and/or stationed on the three landfill caps will not damage the asphalt wearing surface to any appreciable degree. Damage to the asphalt wearing surfaces at the landfill caps must be reported immediately to the SUBASENLON Public Works Environmental Division. Any SUBASENLON department, tenant command or Navy contractor planning projects involving subsurface excavation, subsurface penetration of the soil, dewatering, or ground surface disturbance at the sites depicted in enclosures (1), (2), (3) and (6) shall notify the SUBASENLON IR Program Manager at 694-5649 at the earliest project planning phase and follow the dig permit directions contained in reference (j). The IR Program Manager will coordinate project review with the Naval Facilities Remedial Project Manager, the SUBASENLON Public Works Planning Division, the Public Safety Department, and the USEPA and the CTDEP, as applicable under references (a) through (n). Based on the outcome of this coordination, the SUBASENLON IR Program Manager will provide guidance for projects proposing ground surface disruption, subsurface excavation, penetration, or dewatering work in accordance with enclosures (4) and (5). No work shall commence in IR sites until an excavation permit, as required by reference (j), is completed and signed by the IR Program Manager and the Public Works Planning Division. The excavation permit will specify requirements for the project, detail waste management procedures, and establish standards for protecting remedial infrastructure and restoration of the project site.

D. M. ROSSLER
By direction

Distribution: (SUBASENLONINST 5216.8N)
List D

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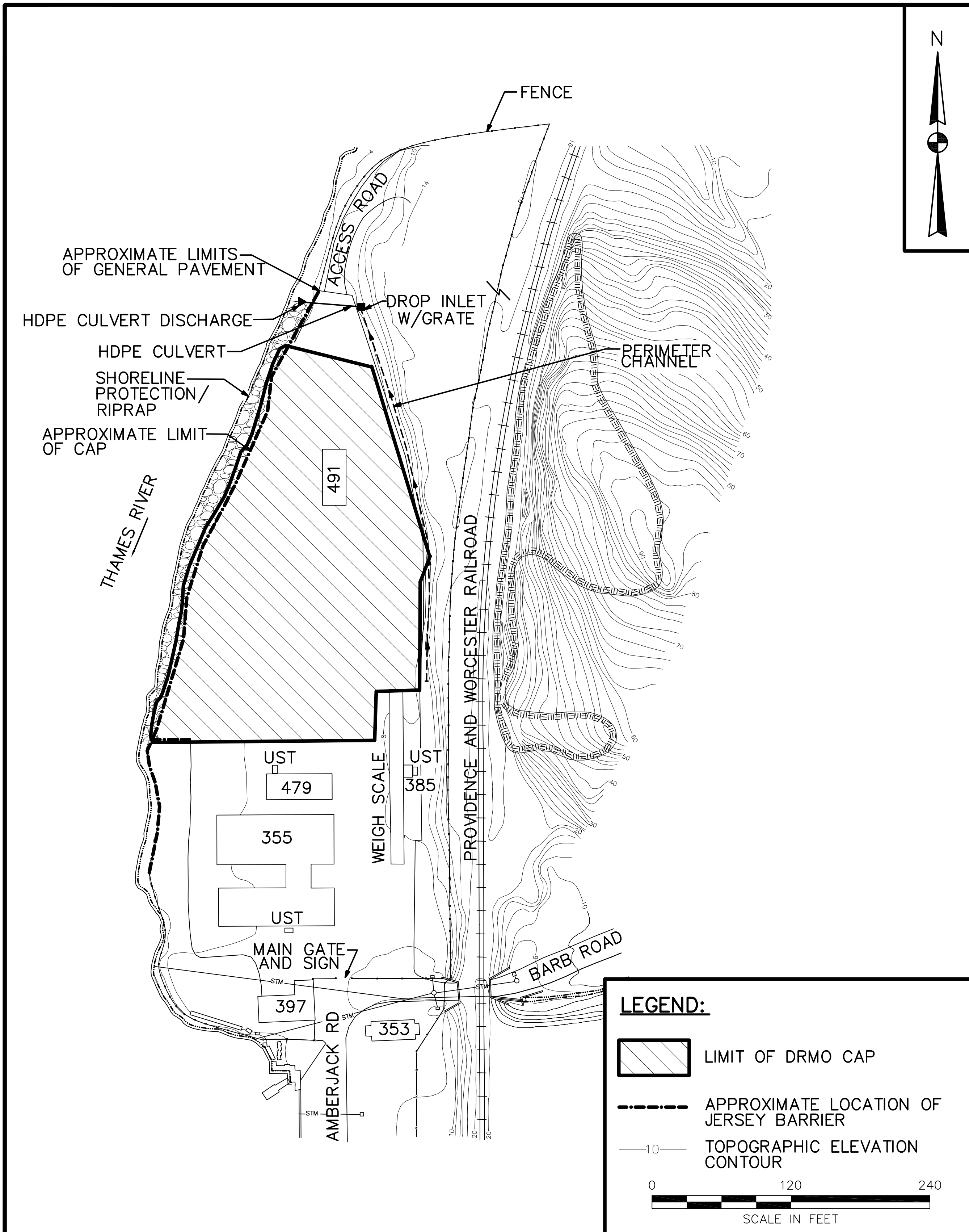

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CHECKED BY	DATE			OWNER NO. 038	
REVISED BY	DATE			APPROVED BY	DATE
SCALE AS NOTED				DRAWING NO. ENCLOSURE 1	REV. 0

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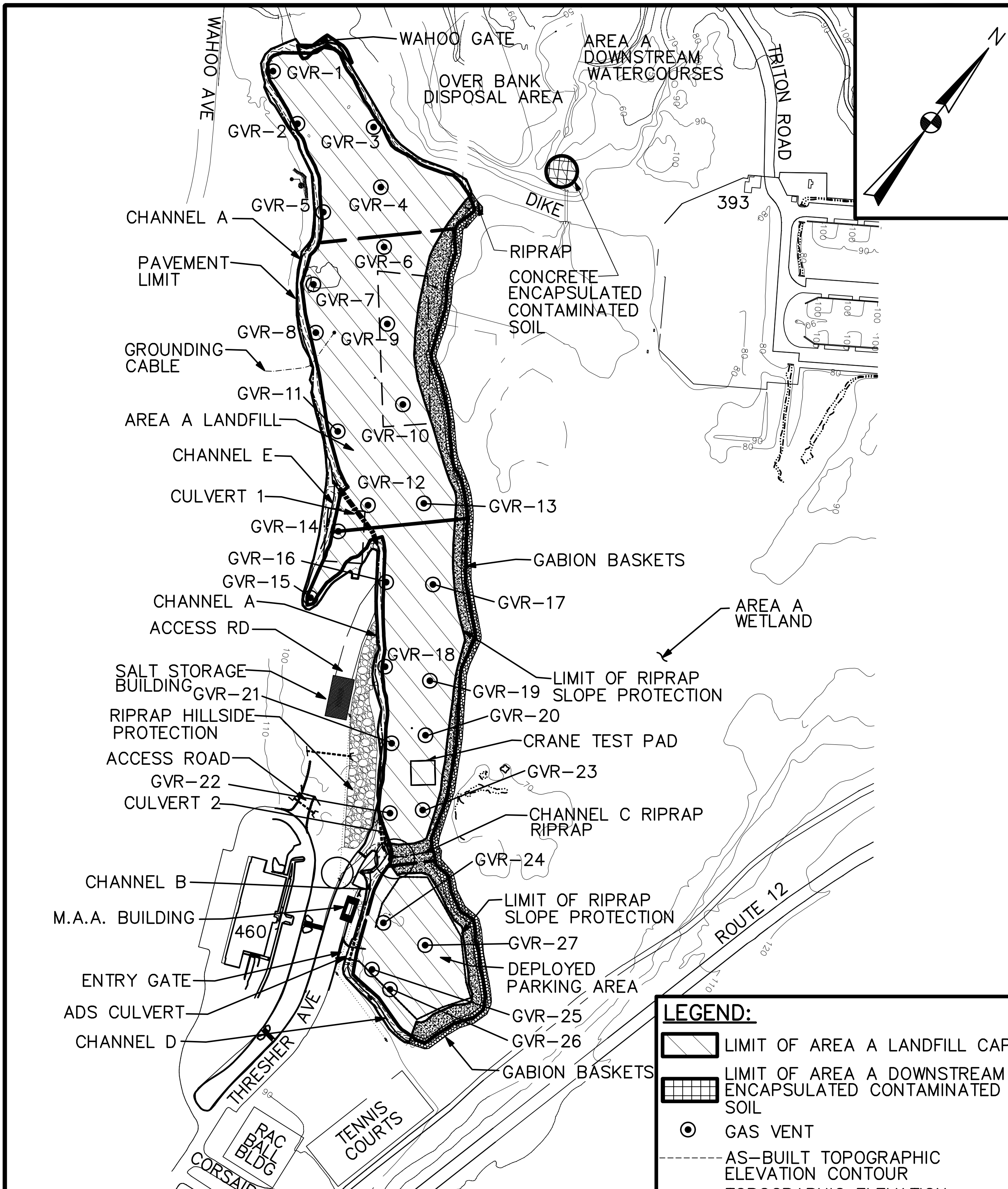


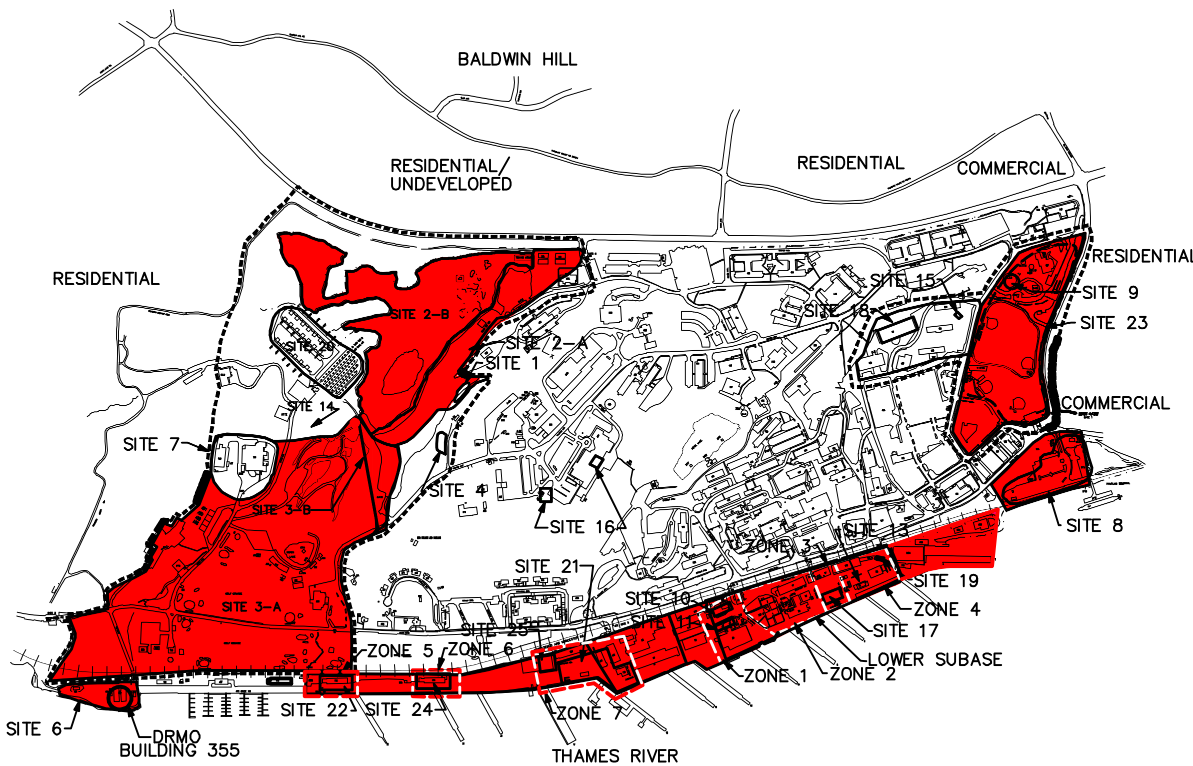
SOURCES:

1. BASE MAP AND UTILITY INFORMATION FROM MAPS OF NSB-NLON AND PHASE II RI WORK PLAN (ATLANTIC, 1993).
2. GAS VENT COORDINATE INFORMATION FROM SAI SURVEY CO. FOSTER WHEELER AS-BUILT REPORT 11-1-97.

DRAWN BY MF — DATE 10/17/06	Tetra Tech NUS, Inc.	AREA A LANDFILL INSTALLATION RESTORATION SITE AND LANDFILL CAP NAVAL SUBMARINE BASE - NEW LONDON GROTON, CONNECTICUT	CONTRACT NO. 0083
CHECKED BY — DATE			OWNER NO. 038
REVISED BY — DATE			APPROVED BY — DATE
SCALE AS NOTED			DRAWING NO. ENCLOSURE 2 — REV. 0

FORM CADD NO. TTNUS-AV.DWG - REV 1 -9/10/98

ACAD: 0083CM37.dwg 08/08/08 CK PIT



LEGEND:

- SITE BOUNDARY
- OU9 BOUNDARY
- LOWER SUBASE REMEDIAL INVESTIGATION ZONE BOUNDARY
- AREA WITH LUCs ON SOIL AND/OR GROUNDWATER
- LUC LAND USE CONTROL

SITE IDENTIFICATIONS:

SITE 1 – CONSTRUCTION BATTALION UNIT (CBU) DRUM STORAGE AREA
SITE 2 – (A) AREA A LANDFILL AND (B) AREA A WETLAND
SITE 3 – (A) AREA A DOWNSTREAM WATER COURSES AND (B) OVERBANK DISPOSAL AREA (OBDA)
SITE 4 – RUBBLE FILL AREA AT BUNKER A-86
SITE 6 – DEFENSE REUTILIZATION AND MARKETING OFFICE (DRMO)
SITE 7 – TORPEDO SHOPS
SITE 8 – GOSS COVE LANDFILL
SITE 9 – OILY WASTEWATER TANK (OT-5)
SITE 10 – LOWER SUBASE-FUEL STORAGE TANKS AND TANK 54-H
SITE 11 – LOWER SUBASE-POWER PLANT OIL TANKS
SITE 13 – LOWER SUBASE-BUILDING 79 WASTE OIL PIT
SITE 14 – OVERBANK DISPOSAL AREA NORTHEAST (OBDANE)
SITE 15 – SPENT ACID STORAGE AND DISPOSAL AREA (SASDA)
SITE 16 – HOSPITAL INCINERATORS
SITE 17 – HAZARDOUS MATERIALS/SOLVENT STORAGE AREA (BUILDING 31)
SITE 18 – SOLVENT STORAGE AREA (BUILDING 33)
SITE 19 – SOLVENT STORAGE AREA (BUILDING 36)
SITE 20 – AREA A WEAPONS CENTER
SITE 21 – BERTH 16
SITE 22 – PIER 33
SITE 23 – FUEL FARM
SITE 24 – CENTRAL PAINT ACCUMULATION AREA (BUILDING 174)
SITE 25 – LOWER SUBASE-CLASSIFIED MATERIALS INCINERATOR

NOTES:

1. THIS FIGURE SHOULD BE IN COLOR. IF IT IS NOT, PLEASE CONTACT THE ENVIRONMENTAL DEPARTMENT.
2. SITE BOUNDRIES ARE APPROXIMATE
3. SOPA (ADMIN) NEW LONDON INSTRUCTION 5090.18D (2008) INCLUDES SITE USE RESTRICTIONS FOR AREAS WITH SOIL AND GROUNDWATER LUCs.

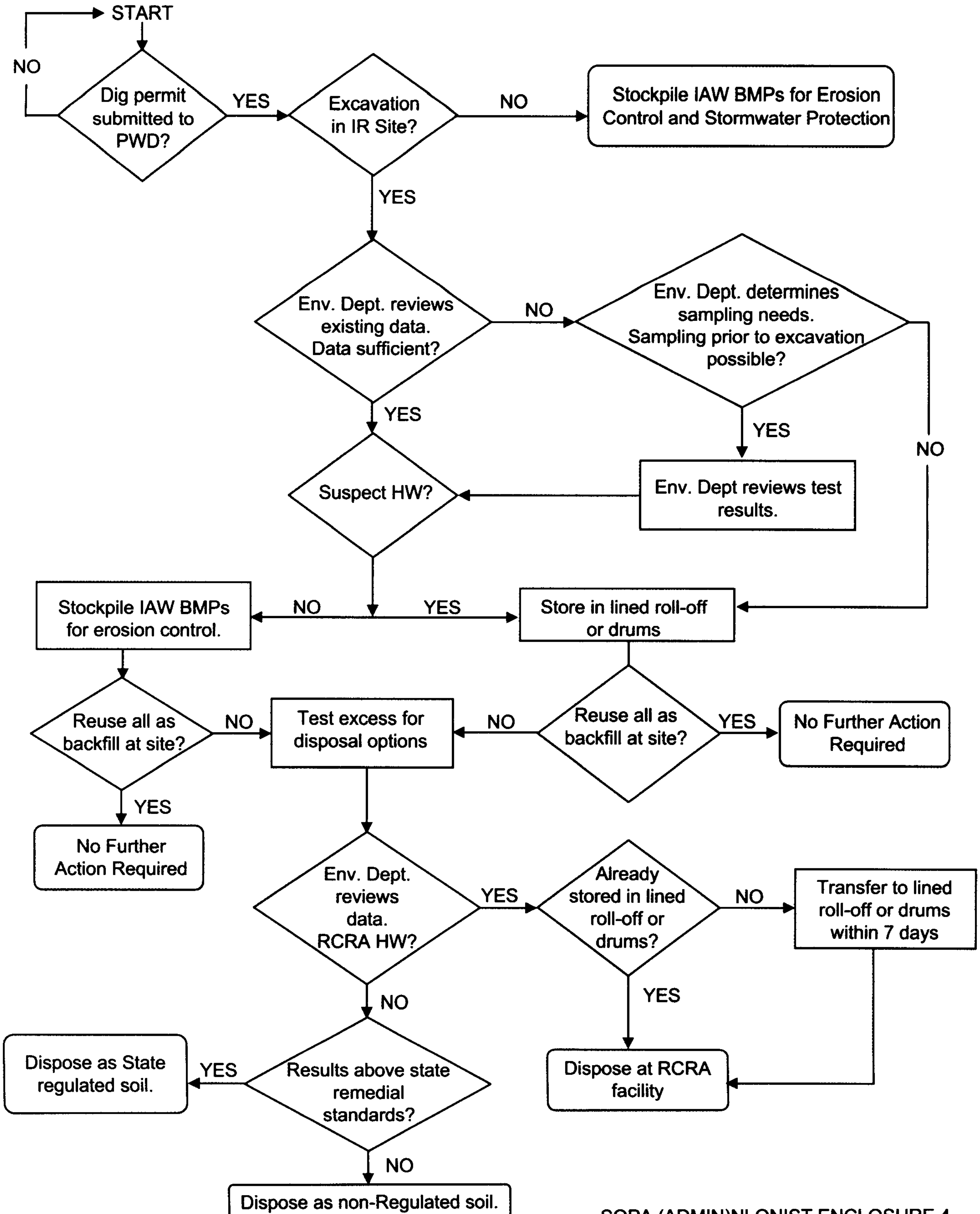
DRAWN BY: CK	DATE: 8/19/08
CHECKED BY: NB	DATE: 8/12/08
REVISED BY:	DATE:
SCALE: AS NOTED	

Tetra Tech NUS, Inc.

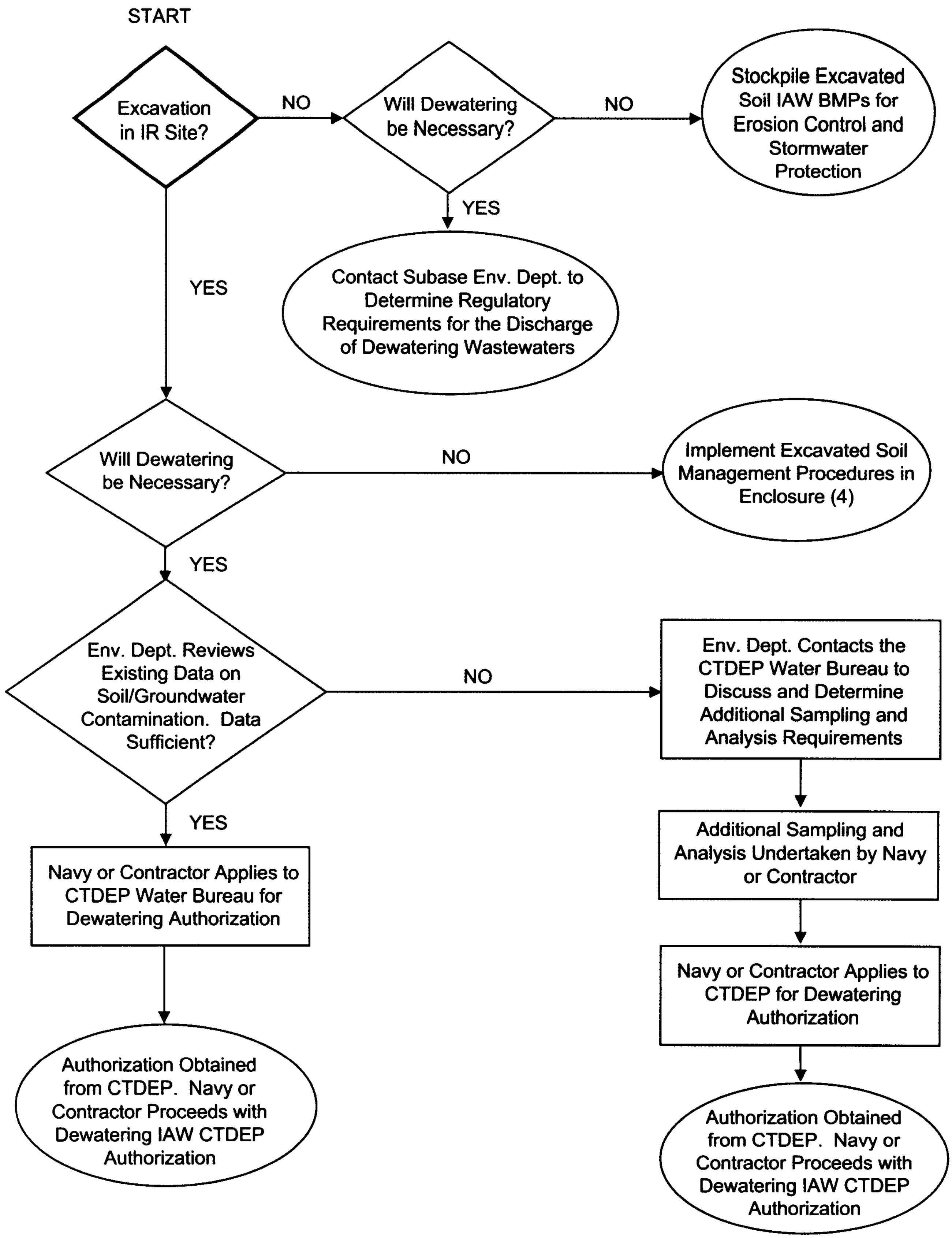
ACTIVE INSTALLATION RESTORATION SITES AND AREAS WITH LAND USE CONTROLS
NAVAL SUBMARINE BASE – NEW LONDON
GROTON, CONNECTICUT

CONTRACT NO. 0777	
OWNER NO. 073	
APPROVED BY: CAR	DATE: 8/19/08
DRAWING NO. ENCLOSURE 3	REV. 0

EXCAVATED SOIL MANAGEMENT FOR INSTALLATION RESTORATION SITES
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT



MANAGEMENT OF DEWATERING WASTEWATERS FOR INSTALLATION RESTORATION SITES
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT



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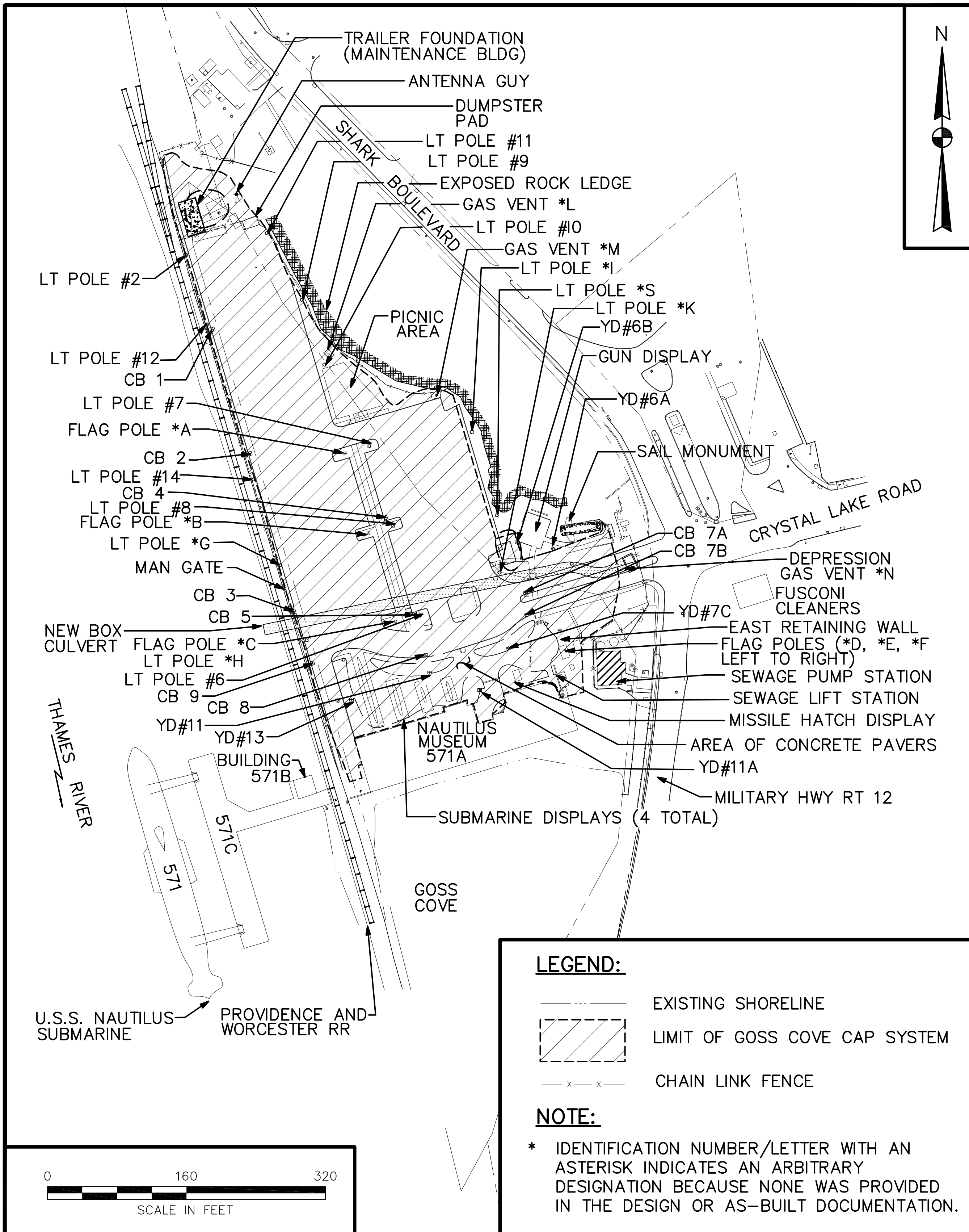

LEGEND:

- EXISTING SHORELINE
- LIMIT OF GOSS COVE CAP SYSTEM
- CHAIN LINK FENCE

NOTE:

* IDENTIFICATION NUMBER/LETTER WITH AN ASTERISK INDICATES AN ARBITRARY DESIGNATION BECAUSE NONE WAS PROVIDED IN THE DESIGN OR AS-BUILT DOCUMENTATION.

0 160 320
SCALE IN FEET

DRAWN BY MF / DATE 10/16/06	Tetra Tech NUS, Inc.	GOSS COVE LANDFILL INSTALLATION RESTORATION SITE AND LANDFILL CAP NAVAL SUBMARINE BASE - NEW LONDON GROTON, CONNECTICUT	CONTRACT NO. 0083
CHECKED BY / DATE			OWNER NO. 038
REVISED BY / DATE			APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. ENCLOSURE 6 / REV. 0

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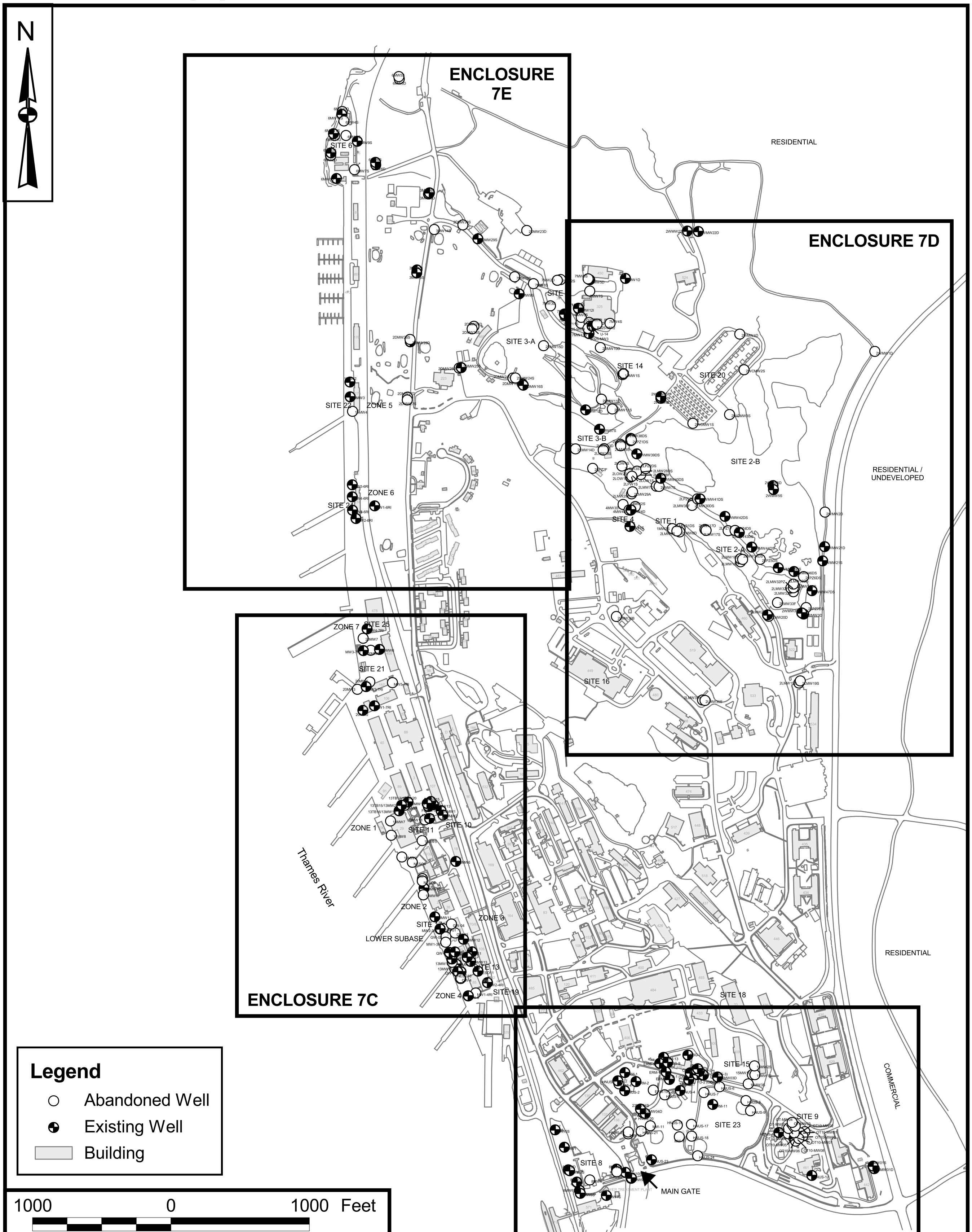

DRAWN BY J. ENGLISH	DATE 08/13/08	Tetra Tech NUS, Inc.	CONTRACT NUMBER CTO 0073 / OWNER NUMBER 0777
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COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. ENCLOSURE 7A / REV 0

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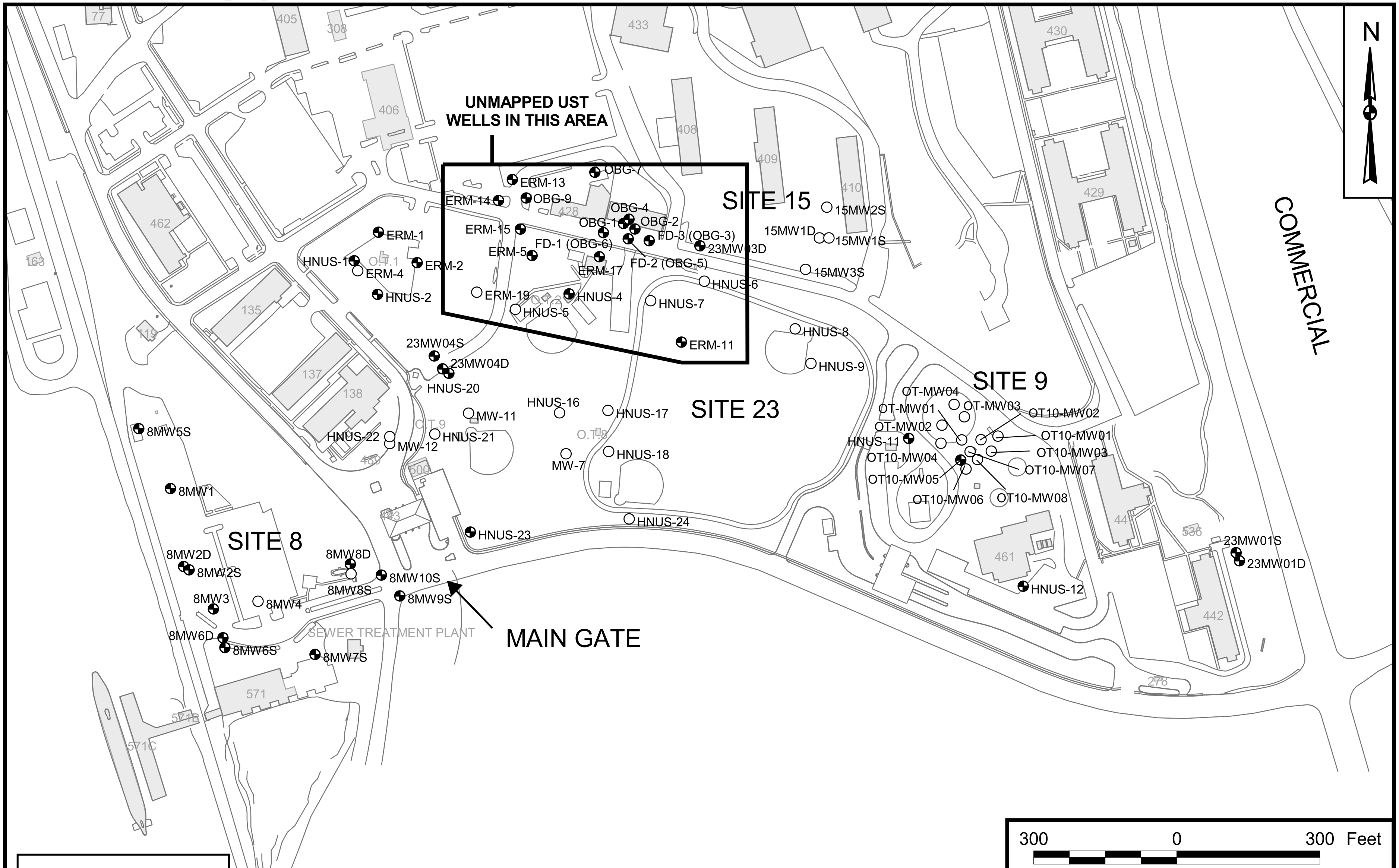

DRAWN BY	DATE	Tetra Tech NUS, Inc.	CONTRACT NUMBER	OWNER NUMBER
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N. BALSAMO	08/15/08		CAR	08/19/08
COST/SCHEDULE-AREA			APPROVED BY	DATE
SCALE			DRAWING NO.	REV
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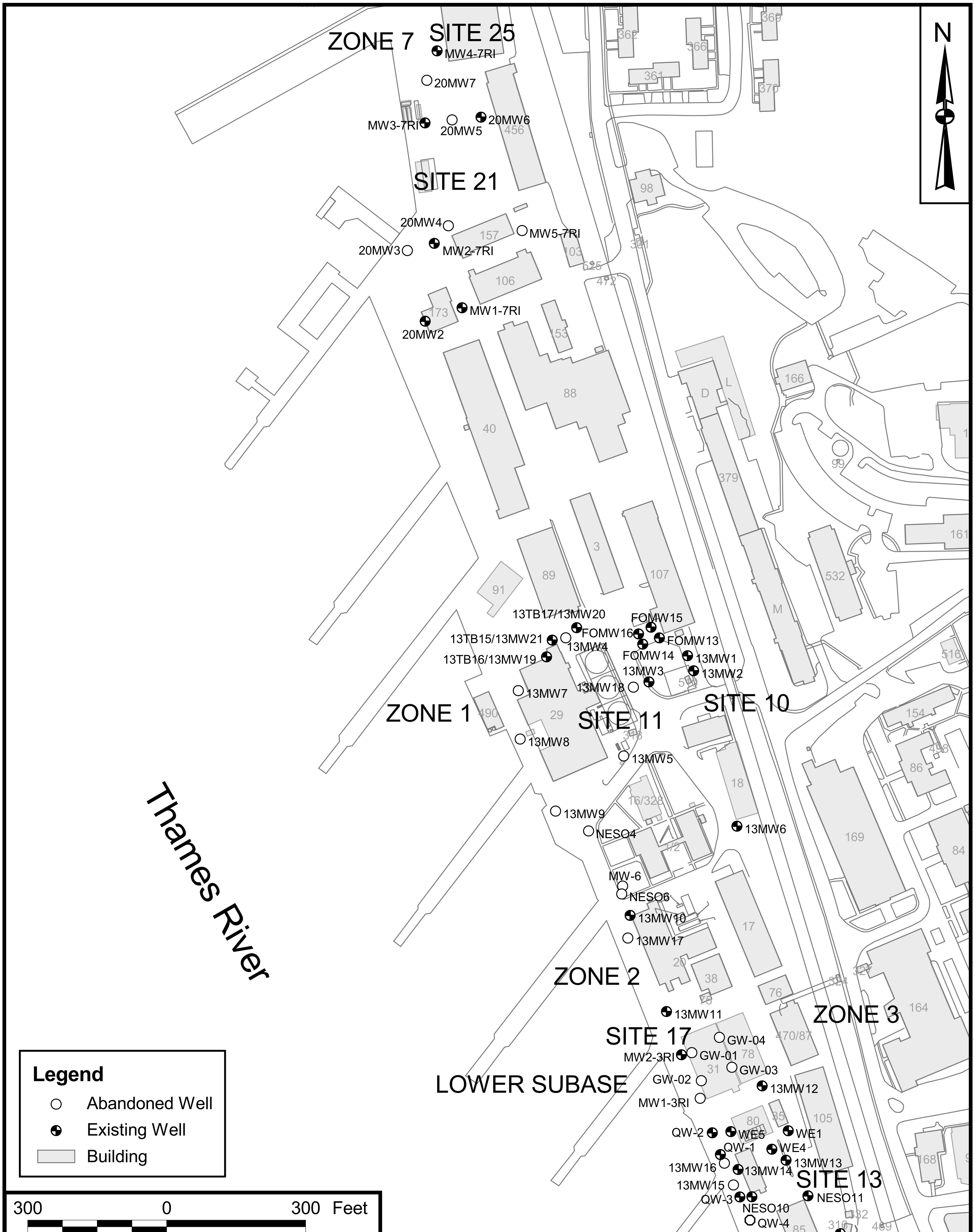

DRAWN BY J. ENGLISH	DATE 08/13/08	Tetra Tech NUS, Inc.	CONTRACT NUMBER CTO 0073	OWNER NUMBER 0777
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COST/SCHEDULE-AREA		SITES 10, 11, 13, 17, 19, 21 AND 25 NAVAL SUBMARINE BASE - NEW LONDON	APPROVED BY	DATE
SCALE AS NOTED		GROTON, CONNECTICUT	DRAWING NO. ENCLOSURE 7C	REV 0

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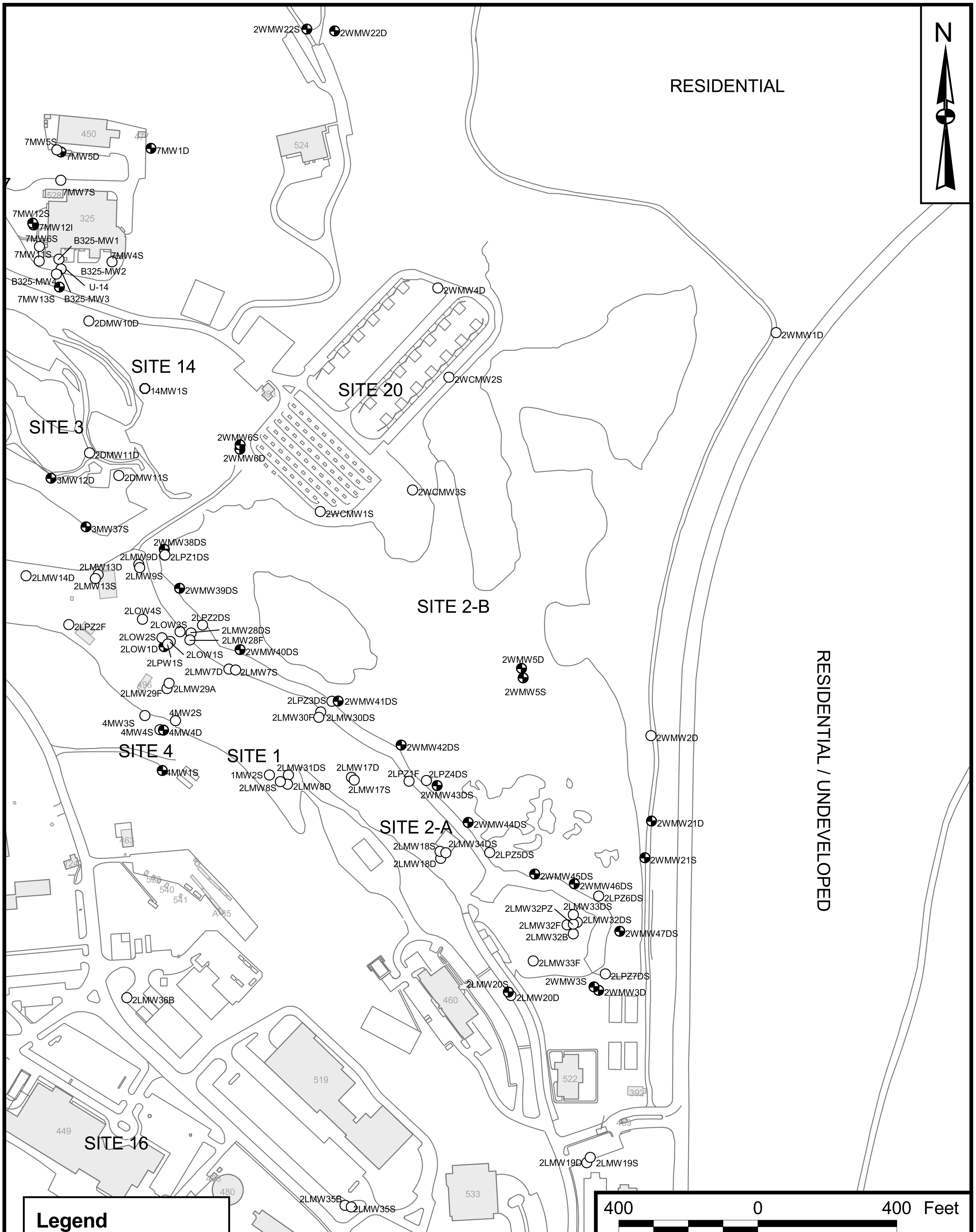

DRAWN BY J. ENGLISH	DATE 08/13/08	Tetra Tech NUS, Inc.	CONTRACT NUMBER CTO 0073	OWNER NUMBER 0777
CHECKED BY N. BALSAMO	DATE 08/18/08	WELL LOCATION MAP SITES 1, 2-A, 2-B, 3, 4, 7, 14 AND 20 NAVAL SUBMARINE BASE - NEW LONDON GROTON, CONNECTICUT	APPROVED BY CAR	DATE 08/19/08
COST/SCHEDULE-AREA			APPROVED BY —	DATE —
SCALE AS NOTED			DRAWING NO. ENCLOSURE 7D	REV 0

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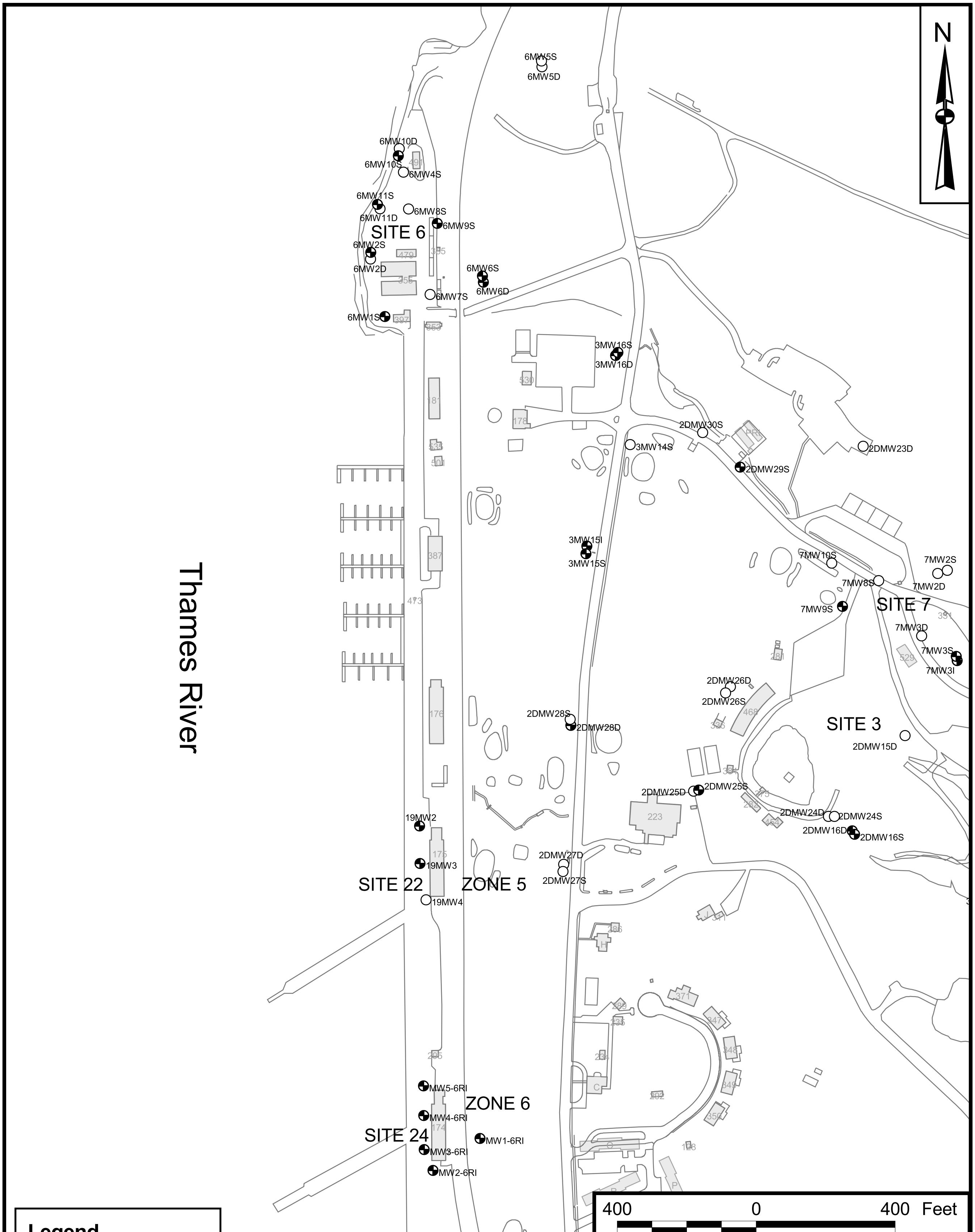

DRAWN BY J. ENGLISH	DATE 08/13/08	Tetra Tech NUS, Inc.	CONTRACT NUMBER CTO 0073	OWNER NUMBER 0777
CHECKED BY N. BALSAMO	DATE 08/18/08	WELL LOCATION MAP SITES 3, 6, 7, 22 AND 24 NAVAL SUBMARINE BASE - NEW LONDON GROTON, CONNECTICUT	APPROVED BY CAR	DATE 08/19/08
COST/SCHEDULE-AREA			APPROVED BY —	DATE —
SCALE AS NOTED			DRAWING NO. ENCLOSURE 7E	REV 0

APPENDIX C

PROPOSED PLAN AND PUBLIC NOTICE

PROPOSED PLAN

Naval Submarine Base - New London, Groton, Connecticut

PROPOSED PLAN FOR BASEWIDE GROUNDWATER OPERABLE UNIT 9

Introduction

In accordance with Section 117 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the law more commonly known as Superfund, this Proposed Plan summarizes the Navy's preferred final options for addressing **groundwater** at the Area A Landfill (Site 2A), Area A Wetland (Site 2B), Area A Downstream Watercourses (Site 3), Torpedo Shops (Site 7), Waste OT-5 (Site 9), Overbank Disposal Area Northeast (Site 14), Spent Acid Storage and Disposal Area (Site 15), Solvent Storage Area (Site 18), Area A Weapons Center (Site 20), and Tank Farm (Site 23) at Naval Submarine Base - New London (NSB-NLON) (Figure 1). The **groundwater** at Sites 2A, 2B, 3, 7, 9, 14, 15, 18, 20, and 23 make up the basewide **groundwater Operable Unit** (**OU**) 9. The **groundwater** at Sites 2A, 2B, 3, 7, 14, and 20 is hydraulically connected. Similarly, **groundwater** at Sites 9, 15, 18, and 23 is also hydraulically connected. The proposed remedial actions for **groundwater** at Sites 3, 7, 14, 15, 18, and 20 were previously presented in a 2004 Proposed Plan and Interim **Record of Decision** (**ROD**). The proposed remedial actions for **groundwater** at those sites were considered interim actions in 2004 because the remaining portions of **OU**9 (Sites 2A, 2B, 9 and 23) were not addressed at that time. In this Proposed Plan, remedial actions are proposed for all portions of **OU**9 (Sites 2A, 2B, 3, 7, 9, 14, 15, 18, 20, and 23 **groundwater**) and this will be the final Proposed Plan for **OU**9. Site 9 is located within Site 23, and **groundwater** issues for the site will be addressed in the proposed remedial action for Site 23. The sites addressed herein are 9 of 23 sites being addressed by the Navy's **Installation Restoration (IR)** Program at NSB-NLON. The **IR** Program identifies and cleans up sites created by past operations that do not meet current environmental standards.

The Cleanup Proposal...

After careful study of **groundwater** at Sites 2A, 2B, 3, 7, 9, 14, 15, 18, 20, and 23, the Navy and EPA propose the following plan:

Groundwater at Sites 2A and 2B

- **Groundwater** at Sites 2A and 2B is currently monitored under a **groundwater monitoring** program selected as part of the remedy for **OU**1. Post-closure **groundwater** monitoring is required by the September 2005 **ROD**. Volumes II and III of the Operation and Maintenance Manual for Installation Restoration Program Sites at Naval Submarine Base New London (January 2006) describe the **groundwater** monitoring plan in detail. This Proposed Plan proposes to continue the monitoring for Sites 2A and 2B as required by the OU1 **ROD**. **Institutional controls** will remain in place at Sites 2A and 2B and are described in the **Site Use Restrictions document**.

Groundwater at Sites 3 and 7

- Continue to implement **institutional controls** that identify the location and magnitude of **groundwater contamination,** restrict extraction and use of the **groundwater,** and control vapor intrusion (Site 3 only) based on land use. (Based on the Interim **ROD**, the **institutional controls** for Sites 3 and 7 were implemented in 2006.)
- Continue to monitor the **groundwater** contaminants until they decrease to levels at which unrestricted use of **groundwater** may be permitted. (Under the Interim **ROD**, a **monitoring** program for Sites 3 and 7 was initiated in 2006.)

Groundwater at Sites 9 and 23

- Implement **institutional controls** that identify the location and magnitude of **groundwater contamination** and restrict extraction and use of the **groundwater**.

Groundwater at Sites 14, 15, 18, and 20

- No Further Action (NFA).

June 26 PUBLIC MEETING AND HEARING

Informational Meeting: 6:30 pm

Formal Public Hearing: 7:00 pm

Date: Thursday, **June 26, 2008**

Location: Best Western Olympic Inn, Route 12, Groton, Connecticut

Learn More About the Proposed Plan

The Navy will describe this Proposed Plan and listen to your questions at an informational public meeting. A formal public hearing will immediately follow this meeting.

For further information regarding the proposed remedy or upcoming meeting, call Mr. Richard Conant with the NSB-NLON Public Works Environmental Division at (860) 694-5649.

Technical terms shown in bold print are defined in the glossary on Pages 29 and 30.

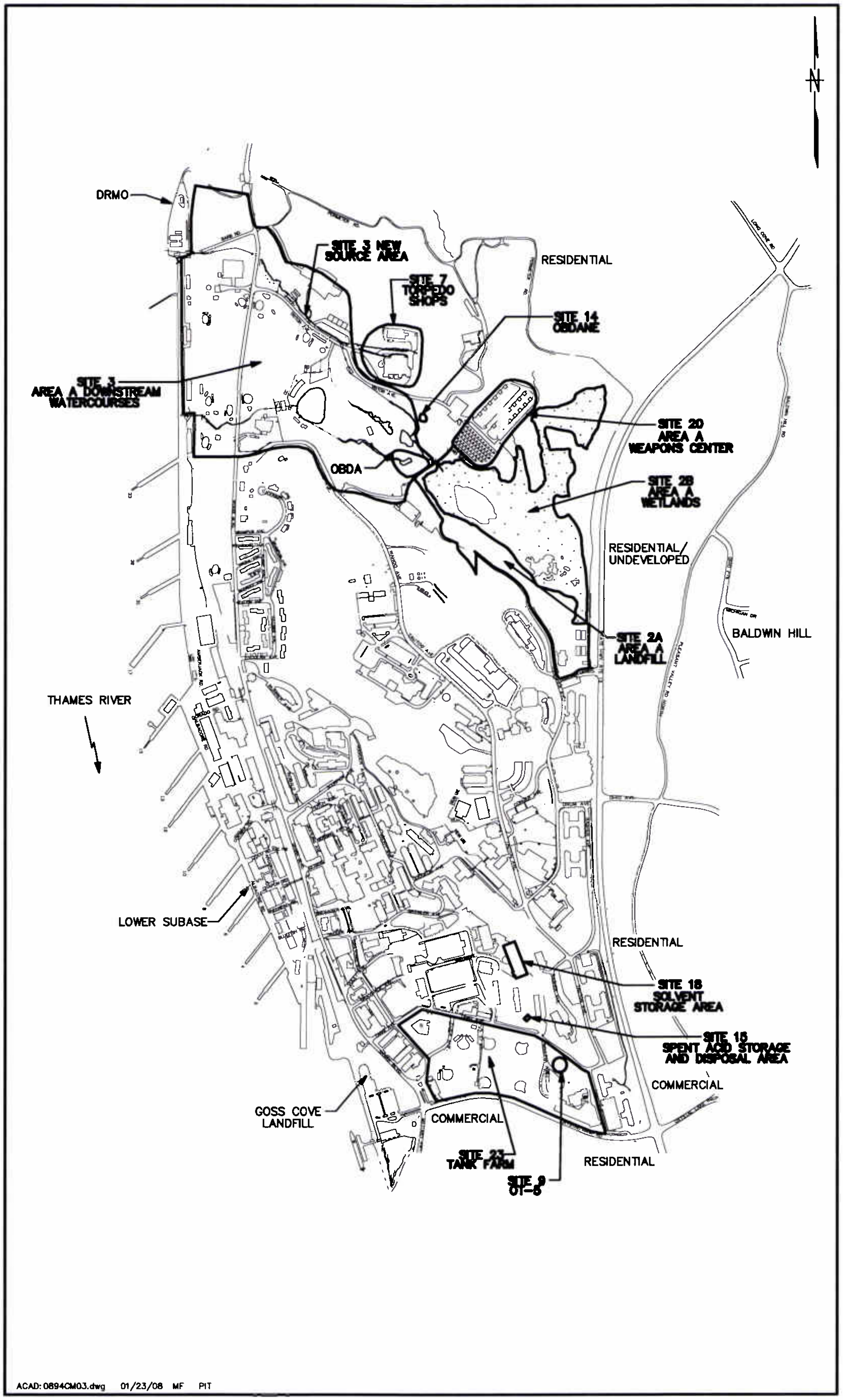

Figure 1. Site Location Map

What Do You Think?

The Navy and EPA are accepting public comments on the final Proposed Plan for **OU9** from June 14, 2008 to July 14, 2008. You do not have to be a technical expert to comment. If you have a comment or concern, the Navy wants to hear from you before making a final decision.

There are two ways to formally register a comment:

1. Offer oral comments during the **June 26, 2008** public hearing, or
2. Send written comments postmarked no later than July 14, 2008 following the instructions provided at the end of this Proposed Plan.

To the extent possible, the Navy will respond to your oral comments during the June 26, 2008 public meeting. In addition, regulations require the Navy to respond to all formal comments in writing. The Navy will review the transcript of the comments received at the meeting, and all written comments received during the formal comment period, before making a final decision and providing written responses to the comments in a document called a **Responsiveness Summary**. The **Responsiveness Summary** will be included in the **ROD**.

Introduction

The Navy conducted various field investigations at Sites 2A, 2B, 3, 7, 9, 14, 15, 18, 20, and 23 from 1990 to the present to assess the nature and extent of **groundwater contamination**. The investigations at Sites 2A, 2B, 3, 7, 20, and 23 focused on the **groundwater** present in the overburden and bedrock, and the investigations at Sites 9, 14, 15, and 18 focused on the **groundwater** in the overburden. Overburden and bedrock **groundwater potentiometric contours** and flow directions at Sites 2A, 2B, 3, 7, 14, and 20 are presented in Figures 2 and 3, respectively. Sites 2A and 2B are located hydraulically upgradient of Site 3. Site 20 is located hydraulically upgradient of Sites 3 and 7. Overburden and bedrock **groundwater potentiometric contours** and flow directions at Sites 9, 15, and 23 are presented on Figures 4 and 5, respectively. **Groundwater** flow directions at Site 18 are shown on Figure 6. **Risk assessments** were also performed to evaluate the potential effects of the **contamination** found in the **groundwater** at Sites 2A, 2B, 3, 7, 14, 15, 18, 20, and 23 on human health and the environment.

Detailed descriptions of the sites are provided in the Phase II **RI** (March 1997), **Basewide Groundwater Operable Unit Remedial Investigation (BGOURI)** Report (January 2002), **BGOURI Update/Feasibility Study (FS)** Report (July 2004), and Second Five-Year Review Report (December 2006), which are all available in the Information Repositories at the locations identified on page 19.

The remedial actions for **groundwater** at Sites 3, 7, 14, 15, 18, and 20 are described in the December 2004 Interim **ROD**. The selected remedy for Sites 14, 15, 18, and 20 was No Further Action (NFA). Based on the interim selected remedy of **institutional controls** and **groundwater monitoring** for Sites 3 and 7, a **groundwater monitoring** program for Sites 3 and 7 was initiated in 2006. Also, a remedial design for land use controls was completed in 2005 and a **Site Use Restrictions document** that defines the Navy's policy regarding disturbance of **groundwater** at IR sites was updated in 2006 to include Sites 3 and 7 **groundwater**.

This Proposed Plan recommends final measures of **institutional controls** and **monitoring** for the **groundwater** at Sites 3 and 7. This recommendation is based on recent **monitoring** results in conjunction with the **BGOURI Update** report's conclusion that there were no significant risks to current human or ecological receptors, but there are potentially significant risks to hypothetical future human receptors from routine, long-term consumption of contaminated **groundwater**.

This Proposed Plan recommends implementation of **institutional controls** for the **groundwater** at Sites 9 and 23. This recommendation is based on recent **monitoring** results in conjunction with 2008 **risk assessment** memoranda for Sites 9 and 23 that indicated that there were no significant risks to current human or ecological receptors, but there are potentially significant risks to hypothetical future human receptors from routine, long-term consumption of contaminated **groundwater**.

This Proposed Plan also recommends NFA for the **groundwater** at Sites 14, 15, 18, and 20. The conclusion that there were no significant risks to human health or the environment from current or future exposure to **groundwater** was presented in the **BGOURI** report for Site 18; in the **BGOURI Update** report for Sites 14, 15, and 20; and in 2008 **risk assessment** memoranda for Sites 14, 15, 18, and 20. Sites 2A and 2B will continue to be monitored as required by the **OU1 ROD**.

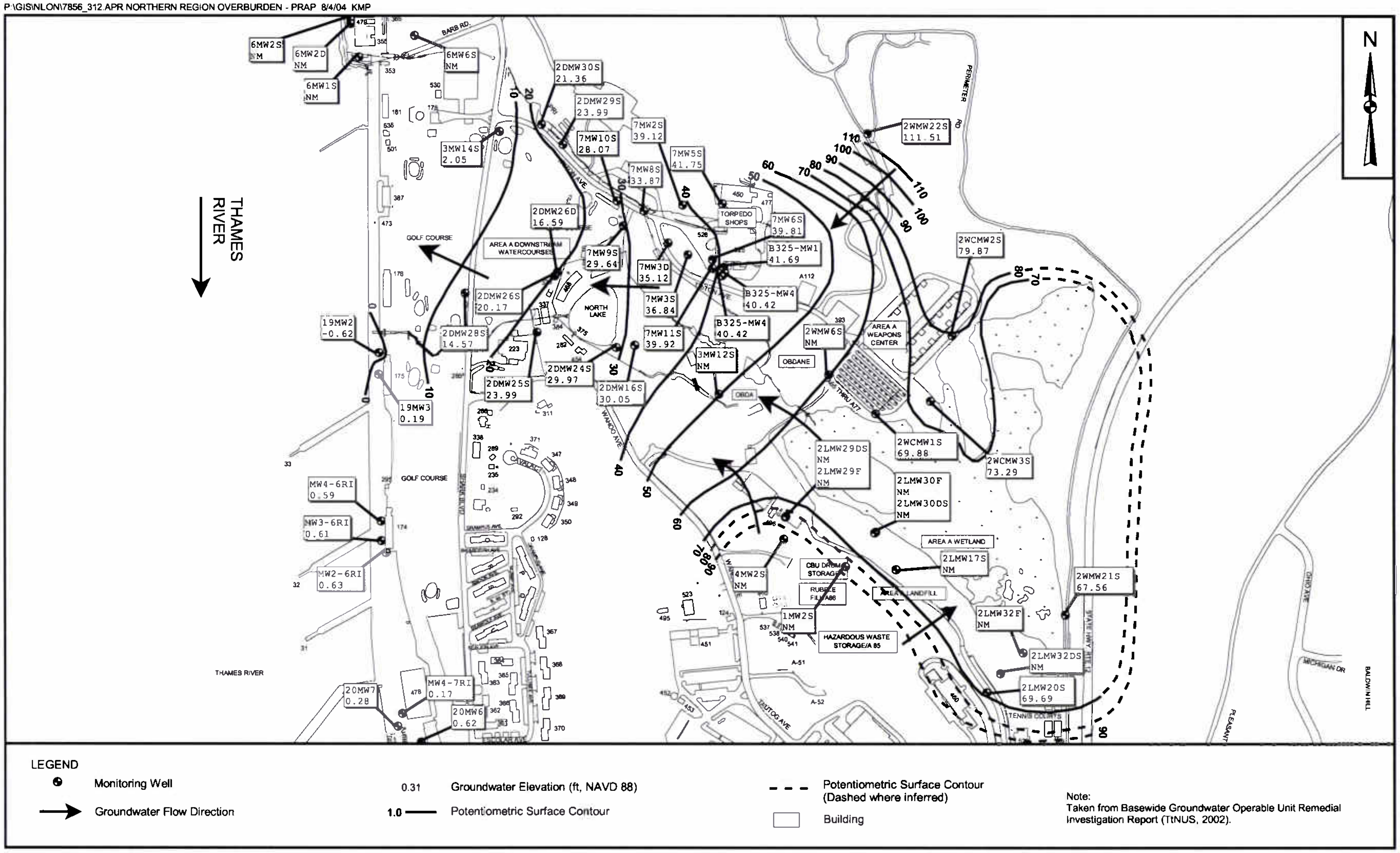

Figure 2. Shallow Overburden Potentiometric Surface Map, Sites 2A, 2B, 3, 7, 14, and 20, August 2000

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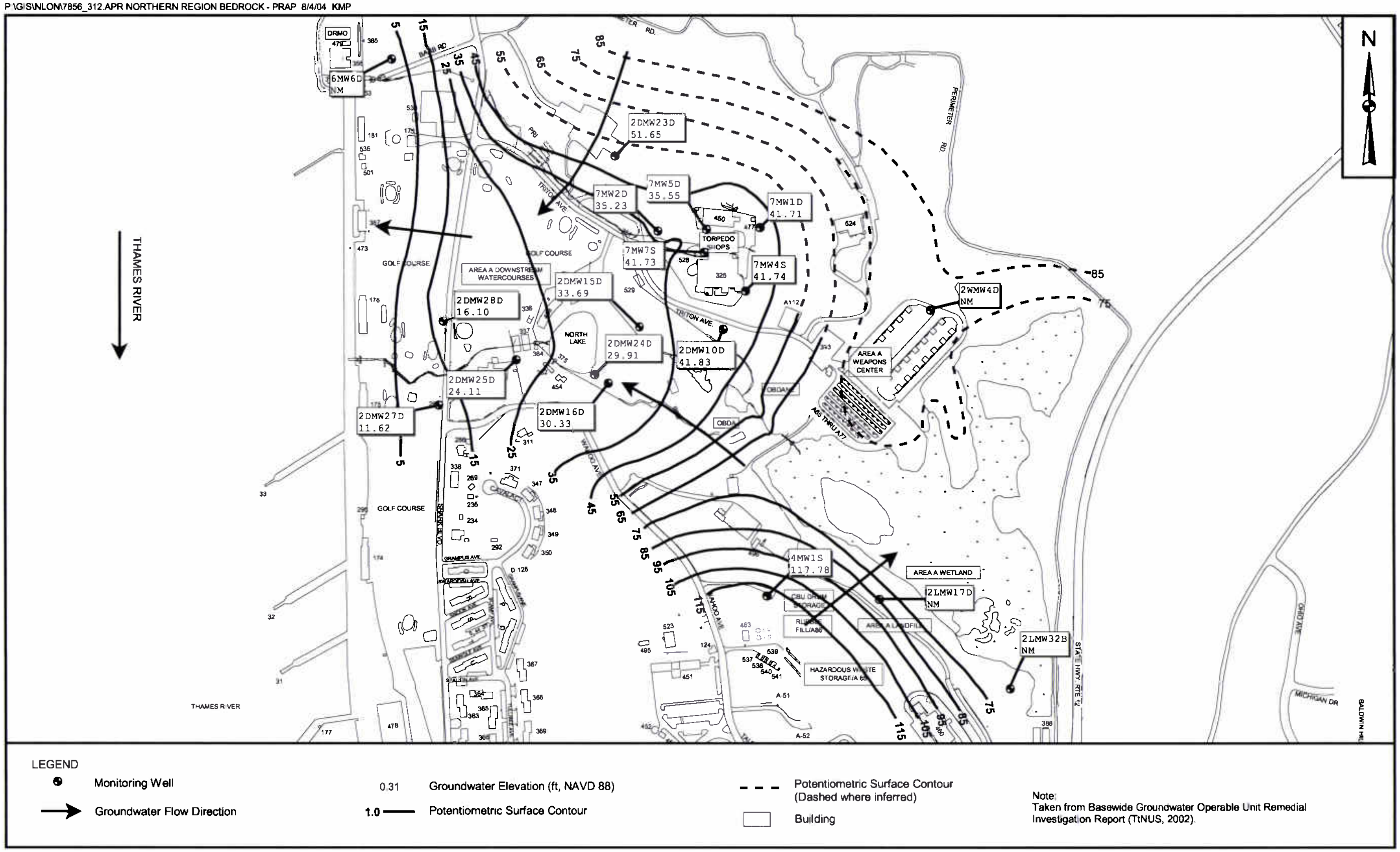

Figure 3. Bedrock Potentiometric Surface Map, Sites 2A, 2B, 3, 7, 14, and 20, August 2000

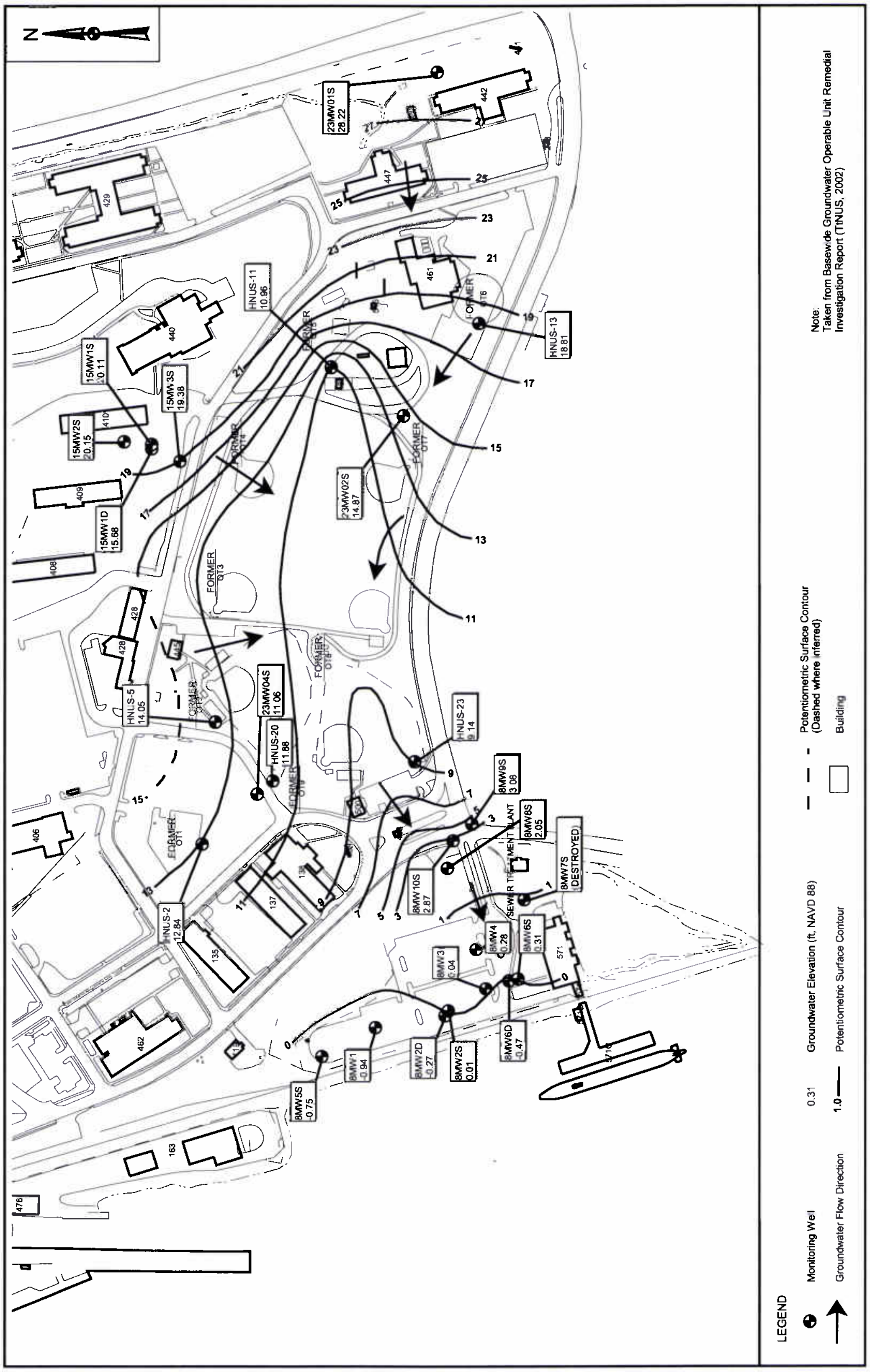

Figure 4. Shallow Overburden Potentiometric Surface Map, Sites 2A, 2B, 3, 7, 14, and 20, August 2000

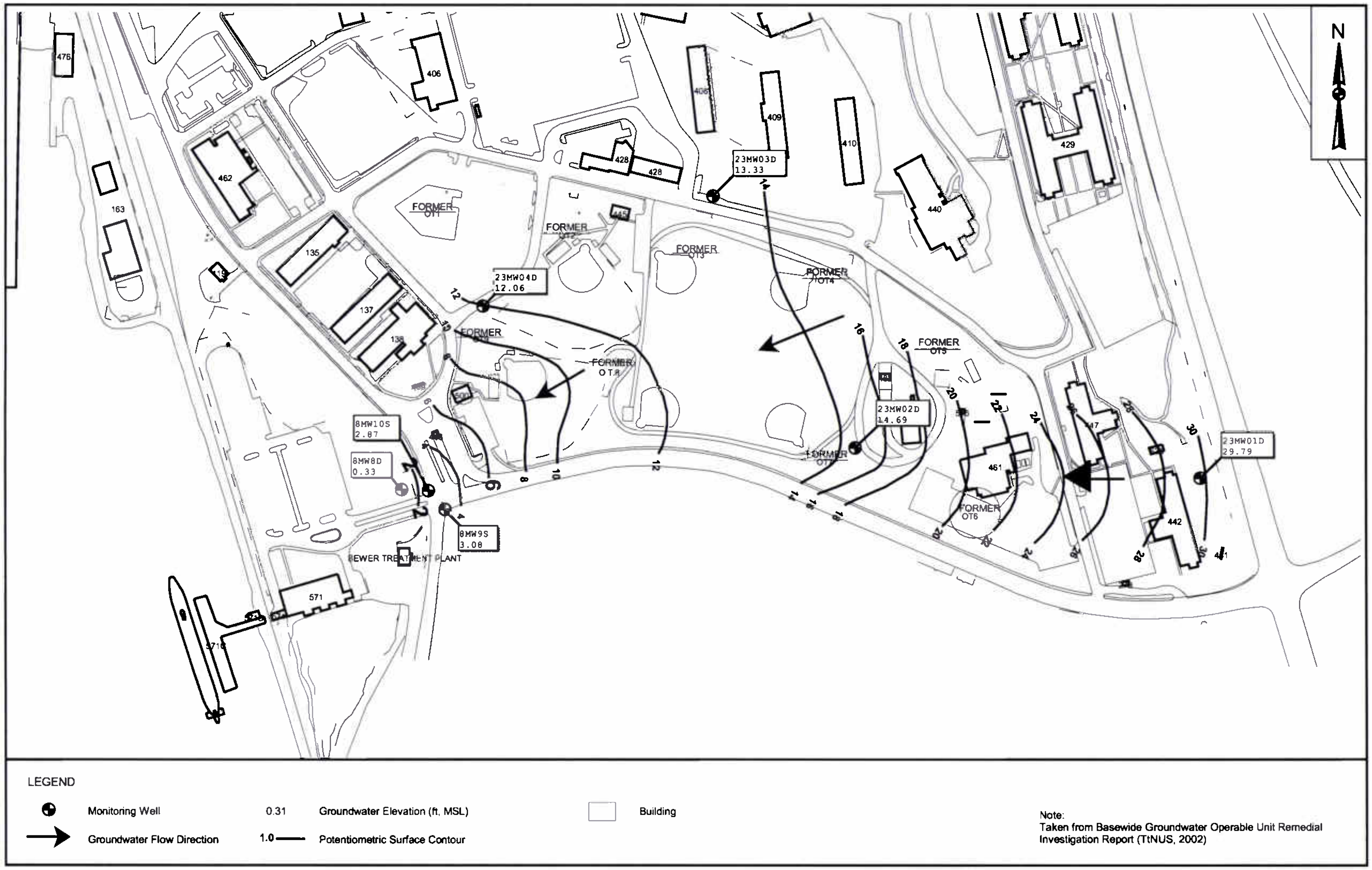

Figure 5. Bedrock Potentiometric Surface Map, Sites 9, 15, and 23, August 2000

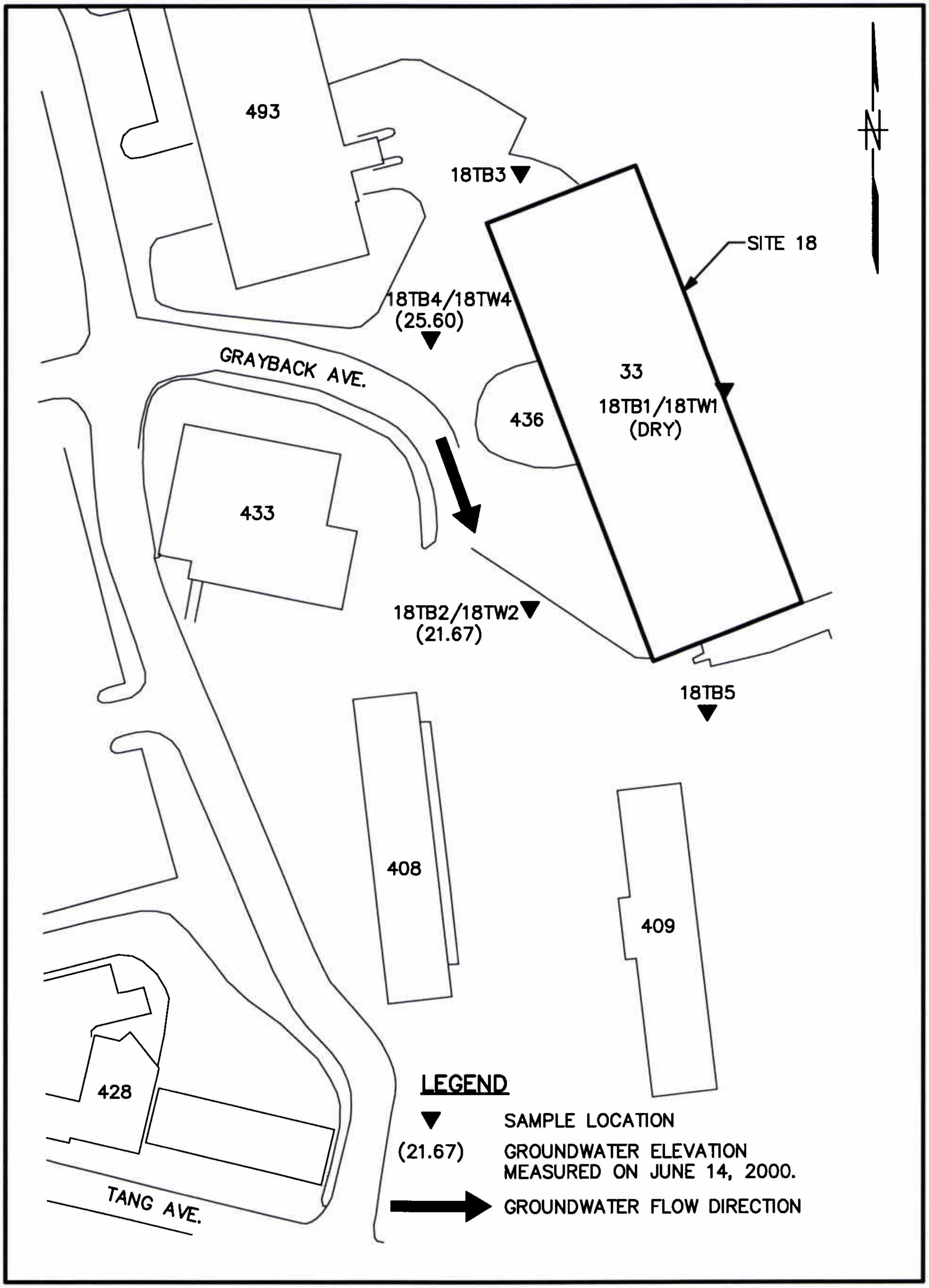

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Figure 6. Site 18 Layout Map

Site Backgrounds, Characteristics, and Investigations

Site 2A

Site 2A includes the Area A Landfill, as shown in Figure 7. Area A Landfill opened around 1957. Incinerated combustible wastes were disposed at the Area A Landfill until 1963, followed by refuse and debris disposal until 1973, when landfilling operations ceased. The thickness of the landfill materials is estimated to range from 10 to 20 feet. After closure, a concrete pad was constructed on a portion of the landfill. In the early 1980s, transformers and electrical switches stored on the pad were reported to be leaking. Petroleum compounds were poured from containers at the landfill and flowed into the Area A Wetland. Spent sulfuric acid solution from batteries was poured into trenches dug in to Area A Landfill for disposal and subsequently covered with soil.

A Phase I Remedial Investigation (**RI**) (1992), Focused **FS** (1995) and Phase II **RI** (1997) were conducted for the Area A Landfill. The Phase II **RI** concluded that shallow **groundwater contamination** existed at the site, the landfill soil may pose a threat to human receptors from concentrations of PCBs, and chemicals in soil could adversely impact ecological receptors. To address Site 2A soil (**OU**1), a Remedial Action (RA), which involved the construction of a 13-acre low-permeability cover system over the landfill area, was performed in 1997. The **groundwater** at the Area A Landfill is currently monitored under a long-term **groundwater monitoring** program. The **groundwater** at the site was also investigated as part of the **BGOURI** (2002). The **BGOURI** recommended that the **monitoring** program be continued to gather data to evaluate long-term trends in contaminant concentrations and the decision to proceed to an **FS** should be made after sufficient data have been collected and evaluated. Land use controls have been implemented at the landfill to meet the requirements in the soil **ROD**. A majority of the Area A Landfill is paved and is currently used for storage of equipment and vehicles.

The initial **Groundwater Monitoring** Plan (GMP) (1999) for Site 2 called for **monitoring groundwater** and surface water for semivolatile organic compounds (**SVOCs**), volatile organic compounds (**VOCs**), **PAHs**, **metals**, pesticides/PCBs, and various field parameters.

A geochemical investigation completed during Year 3 revealed that the slightly elevated arsenic concentrations detected in the downgradient **monitoring** wells in the Area A Wetland, which were completed in dredged material, are related to the dredged material and not the landfill. It is also likely that the elevated zinc levels were related to the dredged material as well as background conditions.

The geochemical investigation also indicated that the pore water in the dredged material is not participating actively in the local **groundwater** flow system. This conclusion was based on measured hydraulic conductivities (vertical and horizontal) and the observation that the dredged material pore water retains strong signatures of seawater. Therefore, the **monitoring** results do not indicate that the Area A Landfill is acting as a significant **source** of **contamination** to **groundwater** or surface water.

After 4 years of **monitoring**, the revised GMP (2004) called for **monitoring groundwater** and surface water for **SVOCs**, **PAHs**, total and dissolved metals, and field parameters. A decision was made to eliminate **VOCs** and pesticides/PCBs from the Area A Landfill analytical program based on **monitoring** results with no exceedances of criteria for these compounds. The revised **monitoring** list for the Area A landfill is as follows:

- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- BEHP
- Phenanthrene
- Arsenic
- Beryllium
- Cadmium
- Chromium
- Copper
- Lead
- Zinc

Compliance with CTDEP Remediation Standard Regulations (RSRs) for a given constituent in a **groundwater** plume can be shown by two different methods. Compliance is achieved when sampling locations are representative of the plume and:

- The average concentration of the compound in the plume is equal to or less than the applicable criteria for at least four consecutive quarterly sampling periods, or
- Statistical comparisons of upgradient and downgradient concentrations such that the concentration of the compound is not increasing over time.

Site 2 has been monitored for 8 years. Overall the results of seven years of **monitoring** indicate that the cap system is working properly and significant contaminant migration from the landfill is not occurring. The most recent results available, those from Year 7 (2006), determined that copper was the only contaminant detected in **groundwater** in excess of criteria (Figure 8) and this was in a

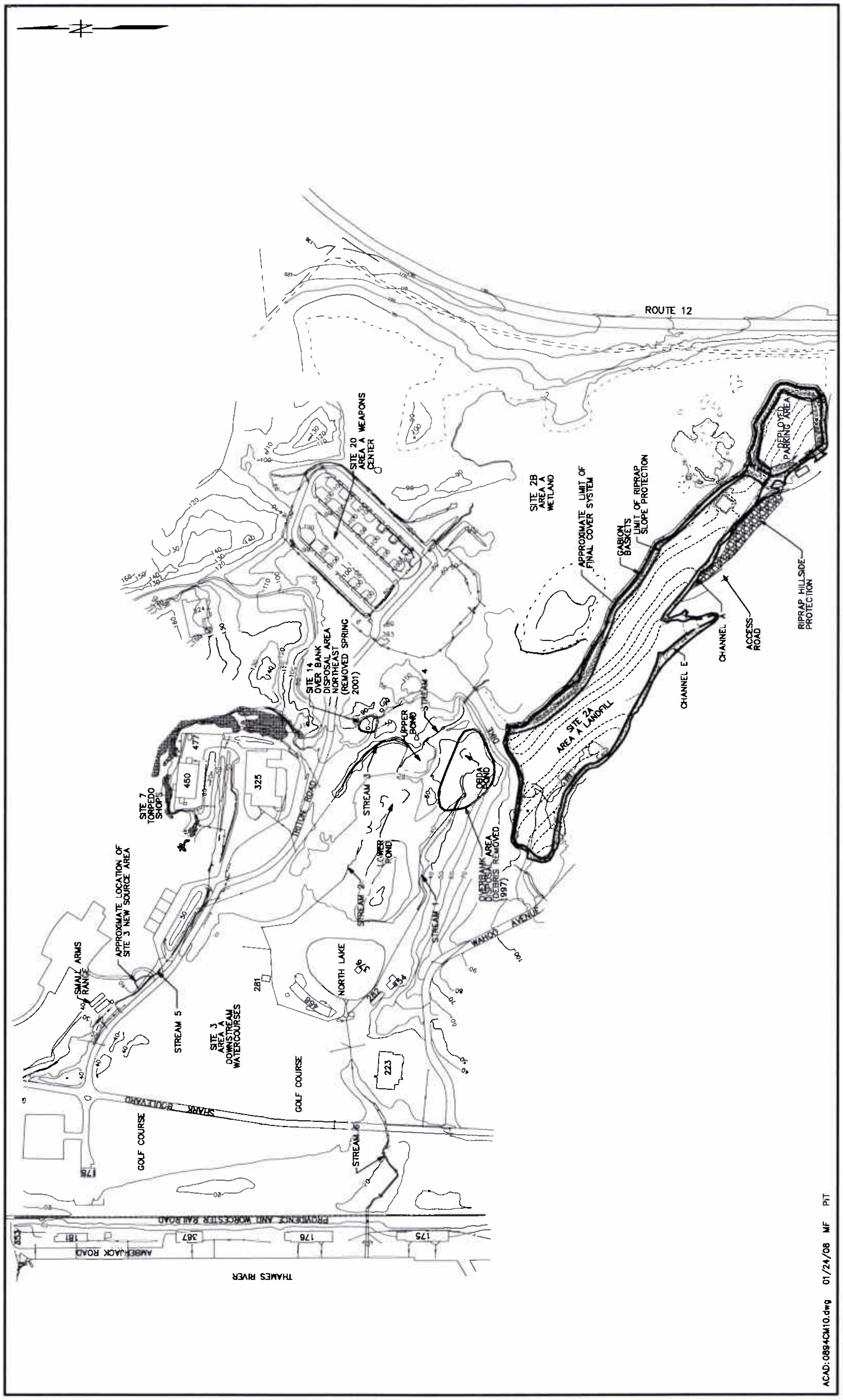


Figure 7. Sites 2A, 2B, 3, 7, 14, and 20 Layout Map

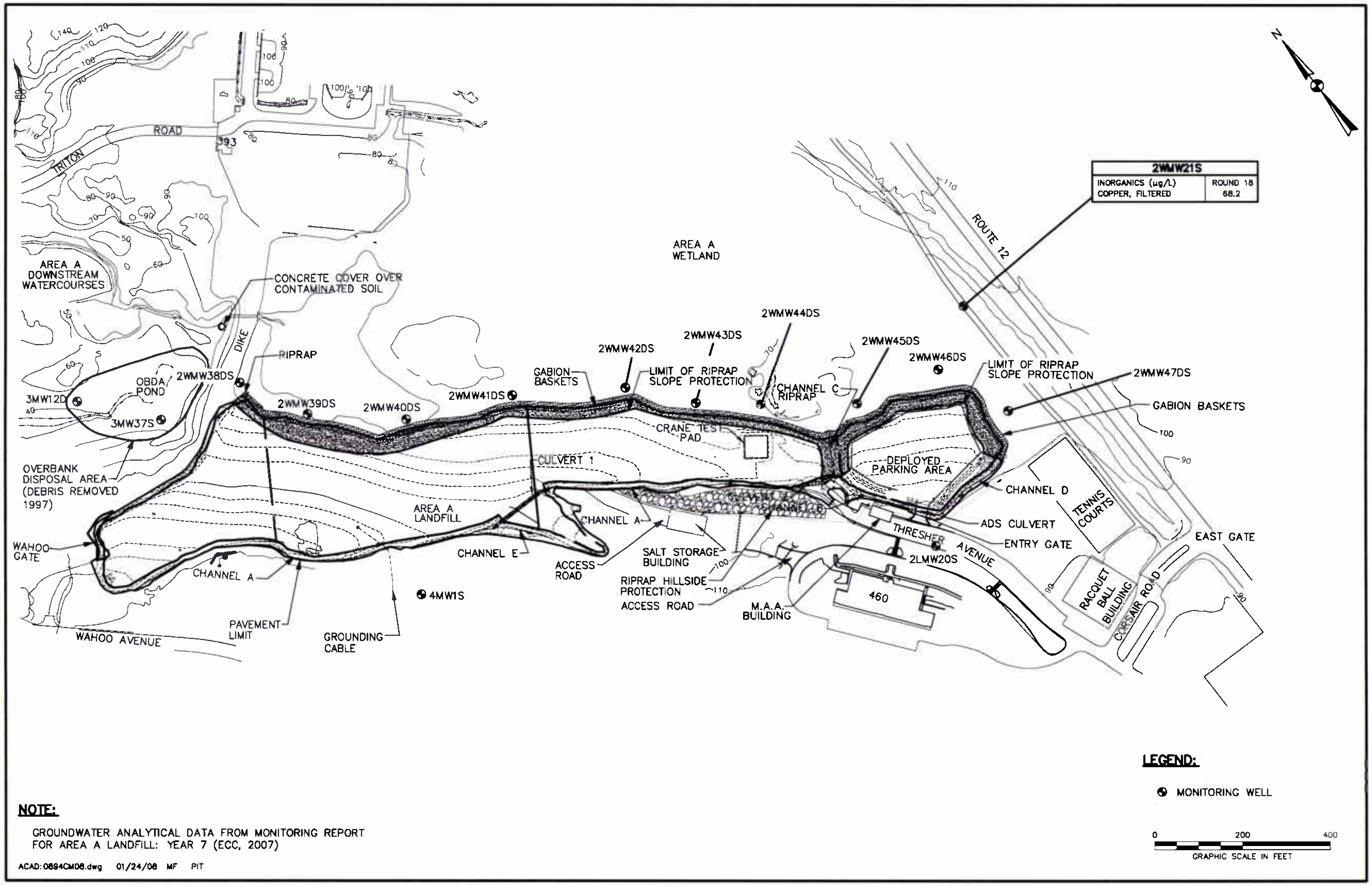


Figure 8. Significant Groundwater Contamination at Sites 2A and 2B

reference well, not a downgradient well. In addition, this well had elevated turbidity, which indicates a suspended sediment issue. The concentrations of copper in all monitored wells exhibited some spikes and appear to have a seasonal component but do not exhibit a clear trend.

The Site 2A human health **risk assessment** performed during the **BGOURI** evaluated potential risks from exposures to **groundwater** by construction workers. The **risk assessment** determined that risks for construction workers were within acceptable risk levels. The **risk assessment** was updated in a 2008 memorandum to account for current **risk assessment** guidance and Year 7 sampling results. The assessment confirmed that risks to construction workers exposed to **groundwater** would be acceptable; however, the assessment showed that there are potential risks to hypothetical residents that would exceed USEPA and CTDEP acceptable levels if **groundwater** is used as a drinking water supply. These risks are mitigated by the existing **institutional controls** that prohibit residential development of Site 2. Potential risks resulting from exposures to chemicals that have volatilized from **groundwater** and migrated through building foundations into indoor air were also evaluated by comparing concentrations of volatile chemicals detected in **groundwater** to USEPA and CTDEP screening criteria for vapor intrusion. Concentrations of chloroform, tetrachloroethene, and trichloroethene exceeded the USEPA screening criteria and they were further evaluated using USEPA's Johnson and Ettinger Vapor Intrusion Model. Modeling results showed that cancer risks and hazard indices for residential and industrial scenarios were within USEPA and CTDEP acceptable levels and vapor intrusion is not an issue at Site 2A.

Site 2B

Site 2B, the Area A Wetland, is located north of the Area A Landfill (Figure 7). In the late 1950s, dredged material from the Thames River were pumped to this area and contained within an earthen dike that extends from the Area A Landfill to the southern side of the Area A Weapons Center. The thickness of dredged material ranges from 10 feet to 35 feet. A small pond is located at the southern portion of the wetland, where 1 to 3 feet of standing water is present year-round. *Phragmites* is the predominant type of vegetation. It was reported that formulated (water-soluble) 1,1,1-trichloro-2,2-bis(4chlorphenyl)ethane (DDT) was used in the 1960s before the 1972 ban. The Phase I and II **RIs** (1992 and 1997, respectively) and the BGOURI (2002) included investigations of the Area A Wetland. The Area A Wetland **sediment** was identified as OU12 and it is currently being investigated under CERCLA.

The Phase II **RI** found little, but some, evidence of **groundwater contamination** at Site 2B. The human health **risk assessment** concluded that carcinogenic risks were within the USEPA target risk range of 1 per 1,000,000 to 1 per 10,000. Non-carcinogenic risks were below the USEPA acceptable level of one. The cumulative hazard index exceeded one for the construction worker but the **risk assessment** assumed that the construction worker would come in direct contact with the soil and **groundwater** for 8 hours a day for 120 days a year. The cumulative non-carcinogenic risks for the construction worker scenario using assumptions of direct contact for 4 hours a day for one month a year are in the acceptable range.

The **risk assessment** was updated in a 2008 memorandum to account for current **risk assessment** guidance and Year 7 sampling results. The assessment confirmed that risks to construction workers exposed to **groundwater** would be acceptable; however, the assessment showed that there are potential risks to hypothetical residents that would exceed USEPA and CTDEP acceptable levels if **groundwater** is used as a drinking water supply. These risks are mitigated by the existing institutional controls that prohibit residential development of Site 2. Potential risks resulting from exposures to chemicals that have volatilized from **groundwater** and migrated through building foundations into indoor air were also evaluated in a separate 2008 memorandum by comparing concentrations of volatile chemicals detected in **groundwater** to USEPA and CTDEP screening criteria for vapor intrusion. Concentrations of trichloroethene and tetrachloroethene exceeded the USEPA screening criteria and they were further evaluated using USEPA's Johnson and Ettinger Vapor Intrusion Model. Modeling results showed that cancer risks and hazard indices for residential and industrial scenarios were within USEPA and CTDEP acceptable levels and vapor intrusion is not an issue at Site 2B.

Sites 3 and 7

Site 3 covers approximately 75 acres in the northern portion of NSB-NLON. The site contains mainly undeveloped wooded areas and recreational areas [golf course and lake for swimming (North Lake)]. The Site 3 watercourses include several small ponds and interconnected streams (Figure 7) that convey surface water to the Thames River. Site 3 also includes the former Over Bank Disposal Area (OBDA). Site 3 was investigated during the Phase I **RI** (1992), Phase II **RI** (1997), Data Gap Investigation (2002), **BGOURI** (2002), and **BGOURI Update/FS** (2004). The major **sources** of **contamination** to Site 3 included historic application of pesticides, abandoned disposal areas, and the septic system leach fields at Site 7. In March 1997, accumulated debris in the OBDA (Figure 7), including discarded wooden pallets, telephone poles, and empty tanks, was removed as part of a Time-Critical Removal Action (TCRA) and disposed off site. During 1999 and 2000, a remedial action was completed for a portion of Site 3 soil and **sediment** (**OU**3). Approximately 18,050 tons of soil and **sediment** contaminated with pesticides and **metals** were excavated and disposed at off-site disposal facilities. The Site 3-New **Source** Area (NSA), discovered during the RA for Site 3 **OU**3, contained petroleum-contaminated soil. The site was a small disposal area on the hillside adjacent to Stream 5, and debris, such as rusted drums and wire cable, was found intermingled with soil and boulders at the site. An RA for the debris and contaminated soil at the site was completed in October 2007.

Most of Site 3 is within designated Explosive Safety Quantity Distance (ESQD) arcs of Site 20; therefore, further development is not planned for this area. Navy regulations prohibit construction of inhabited buildings or structures within these arcs. Although existing buildings operate under a waiver of these regulations, no further construction is planned.

Site 7, the Torpedo Shops (Buildings 325, 450, 477, and 528), is located in the northern portion of NSB-NLON on the northern side of Triton Road (Figure 7). The Navy conducts maintenance activities on torpedoes at the site. Site 7 media were investigated during several phases from 1990 to 2000. Site 7 soil was addressed by the **ROD** for **OU**8 in 2004 and an RA (excavation and off-site disposal) in 2006. The major **sources** of **contamination** at Site 7 included possible historic disposal of solvents/chemicals into two on-site septic systems and leaks or spills associated with on-site underground storage tanks. Contaminated soil was found on the southern side of Building 325, and it appeared to be related to former underground storage tanks used to store fuel oil. **Groundwater** and suspected soil **contamination** on the western side of the building appeared to be related to the septic tank, sewer lines, or leach field associated with the former septic system. The underground storage tanks were closed in the 1990s, and the septic system was abandoned when sanitary sewers were installed in 1983. A soil RA was performed at Site 7 in 2006. Soil was excavated from two locations - south of Building 325, and the former septic tank area west of Building 325. Approximately 1,150 tons of **PAH**-, benzene-, chlorobenzene-, and dichlorobenzene-contaminated soil and 125 tons of asphalt were excavated and disposed off site. Excavations were backfilled with clean soil.

Chlorinated **volatile organic compounds** (**VOC**s) [*e.g.*, cis-1,2-dichloroethene, trichloroethene (TCE), and vinyl chloride] and **PAHs** were the primary contaminants historically detected in the **groundwater** at Site 3. Chlorinated **VOCs** were detected during all of the investigations, and it is likely that their detections are the result of solvents released to **groundwater** via the two septic systems and associated leach fields at Site 7 and migrating downgradient to Site 3. No other potential **source** of the **contamination** was found in the area. Use of the septic systems and leach fields at Site 7 was terminated in 1983 when sanitary sewers were installed. The concentrations of the **VOCs** detected during the 2002 investigation were lower than concentrations detected during previous investigations (1994), indicating that a continuing **source** of **contamination** is not present. The **VOCs** were found primarily along the length of Stream 5. The **PAHs**, which were detected infrequently, were found to be related to suspended solids in samples collected from recently installed and sampled temporary wells and not a site-specific **groundwater** concern. The results of the **risk assessment** showed that there are no unacceptable risks to current receptors from exposure to contaminants in Site 3 **groundwater**, but the maximum concentrations of TCE and vinyl chloride in Site 3 **groundwater** could result in unacceptable risks to hypothetical residents if **groundwater** is used as a drinking water supply.

Potential risks resulting from exposures to chemicals that have volatilized from **groundwater** and migrated through building foundations into indoor air were also evaluated in a 2008 memorandum by comparing concentrations of volatile chemicals detected in **groundwater** to USEPA and CTDEP screening criteria for vapor intrusion. Concentrations of chloroform, trichloroethene, and vinyl chloride exceeded the USEPA screening criteria and they were further evaluated using USEPA's Johnson and Ettinger Vapor Intrusion Model. Modeling results showed that cancer risks and hazard indices for residential and industrial scenarios were within USEPA acceptable levels, but cancer risks from chloroform and vinyl chloride for the residential scenario exceeded CTDEP acceptable levels. Because the concentration of chloroform did not exceed the CTDEP vapor intrusion criteria, it was concluded that there are no vapor intrusion issues associated with chloroform. Further evaluation of vinyl chloride concluded that it does present a potential risk for the residential scenario. A building could be built for industrial purposes in the area where elevated concentrations of vinyl chloride were detected in **groundwater**; however, there would be restrictions on construction of a building for residential purposes within 100 feet of the area unless steps are taken to mitigate the vapor intrusion issue (subslab depressurizing system). As a result, the **NSB-NLON IR Site Use Restrictions document** for Site 3 will be expanded to include controls on vapor intrusion issues until **groundwater** concentrations reduce to levels at which vapor intrusion is no longer deemed an issue. Site 3 land use is currently industrial and no significant risks are expected from exposures resulting from the migration of vinyl chloride from **groundwater** into indoor air since there are no buildings in the area of the exceedance and vinyl chloride was detected infrequently in **groundwater**. As previously mentioned, most of Site 3 is within designated ESDQ arcs for Site 20 and further development is not planned within this area.

Investigations at Site 7 found benzene, chlorobenzenes (1,4-dichlorobenzene, chlorobenzene, and hexachlorobenzene), phenanthrene, and TCE in the **groundwater**. The contaminants were probably released to the **groundwater** via the two septic systems and associated leach fields historically used at the site. The results of the **risk assessment** showed that there are no unacceptable risks to current receptors from exposure to contaminants in Site 7 **groundwater**, but the maximum concentrations of benzene, chlorobenzenes, and TCE in Site 7 **groundwater** could result in unacceptable risks to hypothetical residents if **groundwater** is used as a drinking water supply.

Potential risks resulting from exposures to chemicals that have volatilized from **groundwater** and migrated through building foundations into indoor air were also evaluated in a 2008 memorandum by comparing concentrations of volatile chemicals detected in **groundwater** to USEPA and CTDEP screening criteria for vapor intrusion. Concentrations of trichloroethene exceeded the USEPA screening criterion and it was further evaluated using USEPA's Johnson and Ettinger Vapor Intrusion Model. Modeling results showed that cancer risks and hazard indices for residential and industrial scenarios were within USEPA and CTDEP acceptable levels and vapor intrusion is not an issue at Site 7.

The initial screening of the analytical data also indicated that the maximum concentrations of hexachlorobenzene and phenanthrene could migrate from **groundwater** to surface water. However, upon further evaluation of frequency of detection information, the potential migration was determined to be insignificant.

The **groundwater** chemicals of concern (COCs) for Sites 3 and 7, based on the investigations and **risk assessments** that were conducted, and the remedial goals selected for each of the COCs are as follows:

VOCs

- 1,4-Dichlorobenzene, 75 µg/L (Site 7)
- Benzene, 1 µg/L (Site 7)
- Chlorobenzene, 100 µg/L (Site 7)
- TCE, 5 µg/L (Sites 3 and 7)
- Vinyl chloride, 1.6 µg/L (Site 3)

SVOCs

- Hexachlorobenzene, 1 µg/L (Sites 3 and 7)

In addition to these COCs, the following COCs were identified for the **PAH**-contaminated soil at Site 7. The **groundwater** is monitored for these COCs to evaluate the effectiveness of the soil remediation at Site 7. These COCs will only be analyzed in **monitoring** well 7MW13S.

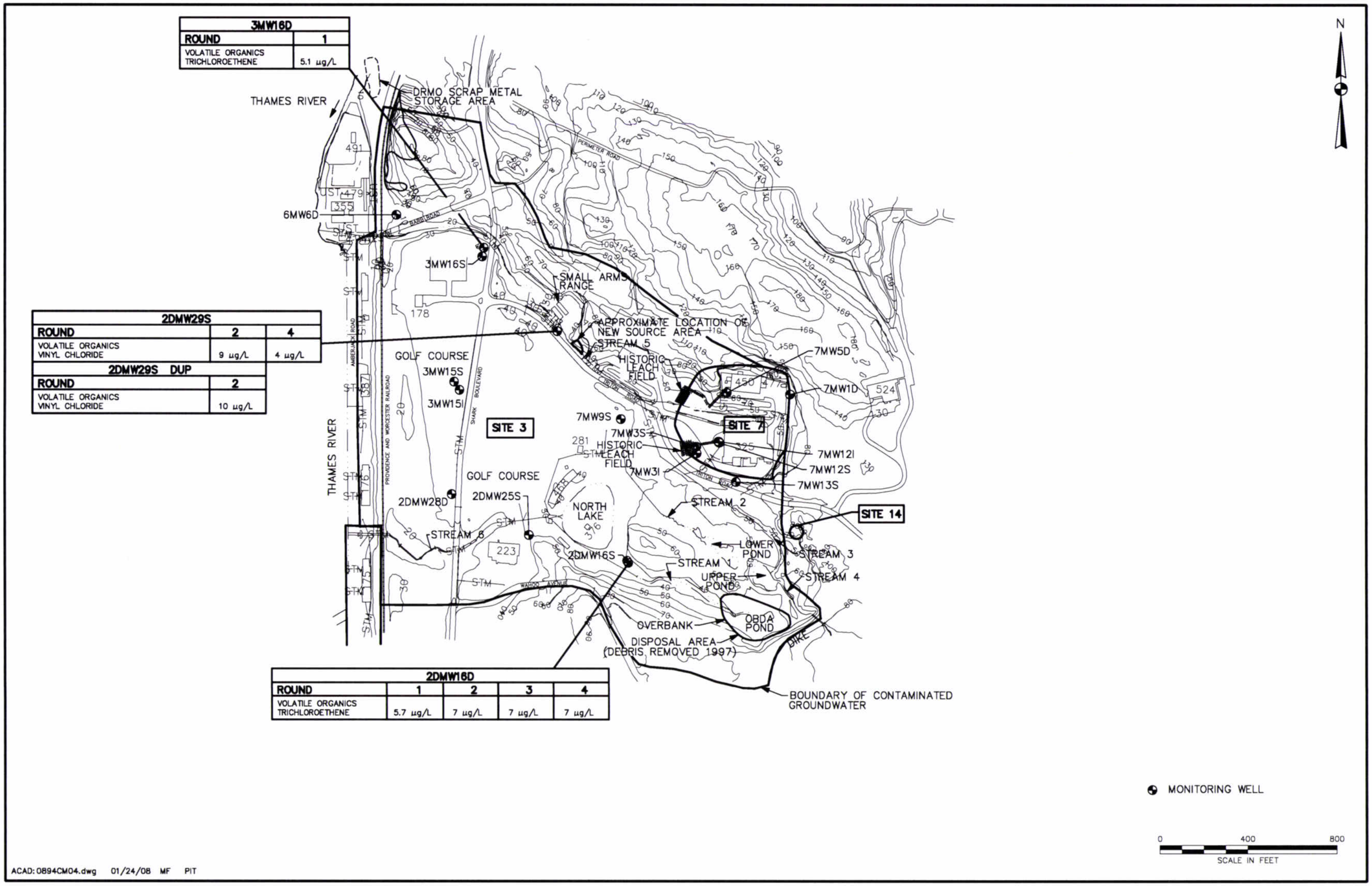
PAHs

- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Indeno(1,2,3-cd)pyrene

Monitored **groundwater** wells and exceedances of remedial goals from the first year (four rounds in 2006-2007) of sampling at those wells are presented on Figure 9. No COCs were detected at several wells. At Site 3, TCE and vinyl chloride were detected in three wells at concentrations that slightly exceeded their remedial goals. It is expected that these contaminants will continue to trend downward and will shortly be below the remedial goals. All compounds at Site 7 were below their remedial goals.

Site 9

Site 9 included OT-5 (Figure 10), a former underground concrete storage tank, located within Site 23 (Figure 11). The soil at Site 9 was investigated and remediated under the CTDEP RCRA UST Program. No CERCLA decision documents were prepared for the soil **OU**. The tank was constructed in the 1940s and was used to store fuel oil. The tank had a capacity of approximately 750,000 gallons. In the late 1970s, the tank was converted to a storage tank for bilge water and other waste solutions. Use of OT-5 was stopped in 1993, and all tank contents were removed. A residual sludge layer of approximately 2 to 3 inches was left in the tank after purging. This sludge contained polychlorinated biphenyls (PCBs) at concentrations exceeding 500 mg/kg. After OT-5 was emptied, **groundwater** infiltrated through cracks in the concrete surface and partially refilled the tank. Residual materials were removed in 1994. After the contents of OT-5 were removed, the tank was cleaned and the top of the tank was crushed. The tank was closed in place by filling it with inert material. Further evaluation of Site 9 **groundwater** is included under Sites 23.



3MW16D	
ROUND	1
VOLATILE ORGANICS TRICHLOROETHENE	5.1 μg/L

2DMW29S		
ROUND	2	4
VOLATILE ORGANICS VINYL CHLORIDE	9 μg/L	4 μg/L

2DMW29S DUP	
ROUND	2
VOLATILE ORGANICS VINYL CHLORIDE	10 μg/L

2DMW16D				
ROUND	1	2	3	4
VOLATILE ORGANICS TRICHLOROETHENE	5.7 μg/L	7 μg/L	7 μg/L	7 μg/L

Figure 9. Significant Groundwater Contamination at Sites 3 and 7

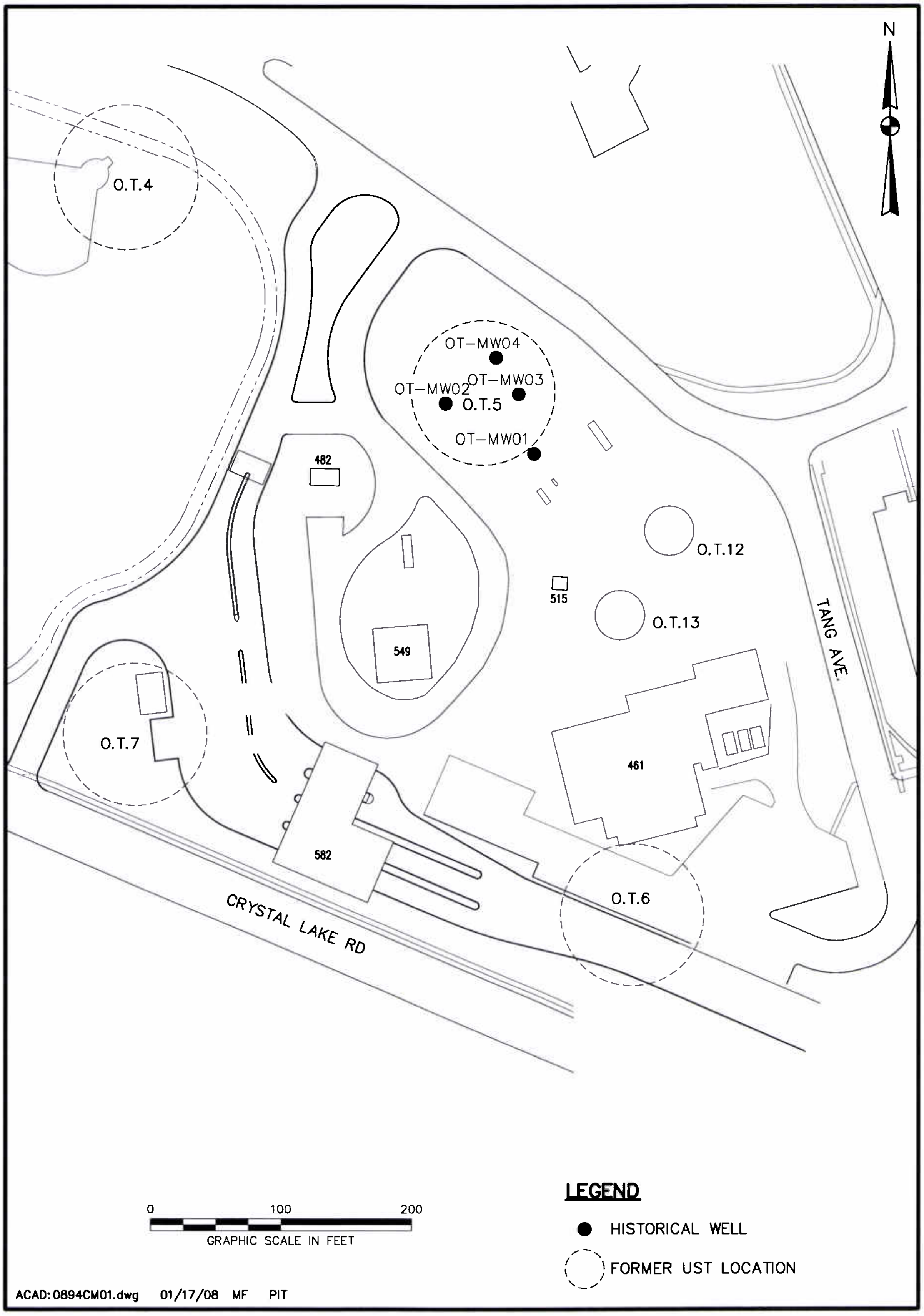


Figure 10. Site 9 Layout Map

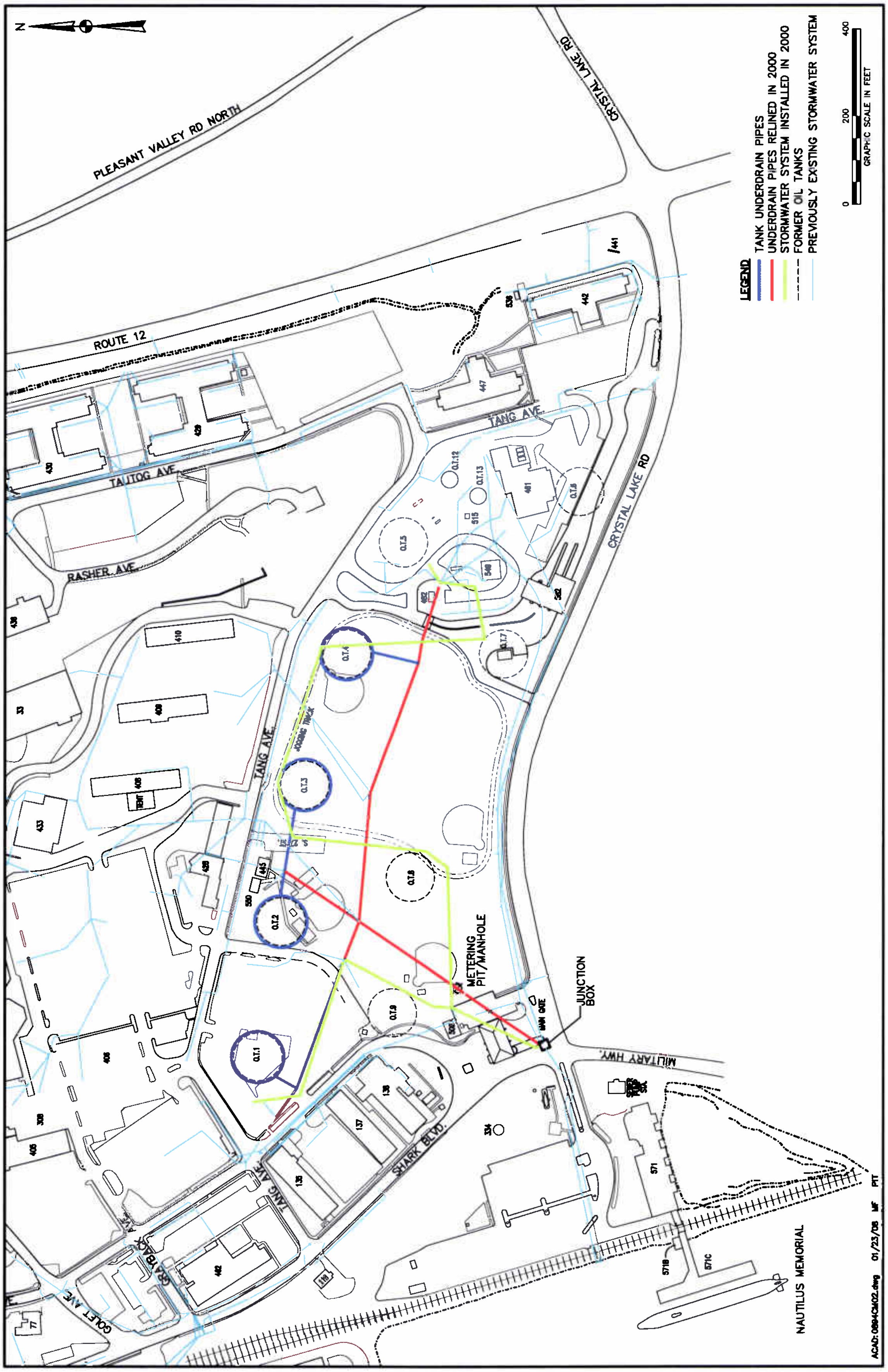


Figure 11. Sites 9 and 23 Layout Map

Site 14

Miscellaneous wastes were dumped at Site 14. It is located adjacent to Sites 3 and 7 in a wooded area on the edge of a ravine just north of Stream 3 (Figure 7). A NTCRA was completed at the site in 2001 to address the soil (**OU**8) and miscellaneous wastes dumped at the site. Approximately 270 tons of material were removed and disposed off site, and the site was subsequently restored.

One **groundwater monitoring** well was installed at Site 14. It was sampled in 1994 and 2000. Naturally occurring **metals** were the only chemicals detected in the **groundwater**. Evaluation of the Site 14 analytical data indicated that there are no adverse health effects anticipated from exposure to **groundwater** at the site.

Site 15

Site 15 is located in the southern portion of NSB-NLON (Figure 1). It is centrally located between the southern sides of Buildings 409 and 410 (Figure 12). This site was used before and after World War II for the temporary storage of waste battery acid in a rubber-lined underground tank. The tank was reportedly 12 feet long by 4 feet wide by 4 feet high. The batteries were placed on a concrete pad next to the tank onto which acids occasionally leaked. No major spills were recorded. A 1951 aerial photograph showed that the area around the tank was not paved. Acid from the batteries was stored in the tank and was subsequently pumped into a tank truck and disposed in the Area A Landfill (Site 2). Historical investigations completed at Site 15 include the Phase I **RI** (1992), Focused **FS** (1994), Phase II **RI** (1997), Supplemental Sampling Event (1997) and **BGOURI** (2002). Based on the results of the Phase I **RI** and Focused **FS**, it was determined that a TCRA was necessary for Site 15. The removal action was completed in 1995 and included removal of the tank, its contents, and 318 tons of lead-contaminated soil. Subsequent to the TCRA, completion of the Phase II **RI**, and confirmation sampling, an NFA **Source** Control **ROD** was signed for Site 15 soil **(OU6)** in 1997.

After the TCRA at Site 15, **groundwater** samples were collected in 2000 at the site during the **BGOURI**. The **BGOURI** identified TCE and **metals** as the **groundwater** chemicals of potential concern (COPCs). TCE had not been detected in previous sampling events. Additional soil and **groundwater** samples were collected during the data gap investigation (DGI) in 2002 to confirm the results of the **BGOURI**, to further define the nature and extent of **contamination** at the site, and to determine the risks to human receptors from exposure to Site 15 soil and **groundwater**. The DGI results were presented in the **BGOURI Update/FS**. TCE was not detected in the DGI **groundwater** samples, which indicated that the detections of TCE found in **groundwater** samples during the **BGOURI** were anomalous and not indicative of a site or upgradient **source** issue. The **metals** cadmium, chromium, lead, nickel, silver, and zinc were identified as **groundwater** COPCs at Site 15 during the **BGOURI**. The results of the DGI showed that the chromium, lead, nickel, and silver concentrations were also anomalies and that the elevated concentrations may have been a result of the field sampling methodology and/or laboratory issues.

The **risk assessment** and data screening completed with the DGI results showed that there are no **groundwater** COCs for Site 15. The **risk assessment** was performed for construction workers and hypothetical adult residents. The results of the **risk assessment** indicated that the risks from direct exposure to **groundwater** were within USEPA and CTDEP acceptable risk levels. Potential risks resulting from exposures to chemicals that have volatilized from **groundwater** and migrated through building foundations into indoor air were also evaluated in a 2008 memorandum by comparing concentrations of volatile chemicals detected in **groundwater** to USEPA and CTDEP screening criteria for vapor intrusion. Concentrations of chloroform exceeded the USEPA screening criterion and it was further evaluated using USEPA's Johnson and Ettinger Vapor Intrusion Model. Modeling results showed that cancer risks and hazard indices for residential and industrial scenarios were within USEPA and CTDEP acceptable levels and vapor intrusion is not an issue at Site 15.

Site 18

Site 18 consists of Building 33, the Solvent Storage Area. The location of Site 18 is shown on Figures 1 and 6. Building 33 has been used for the storage of gas cylinders and 55-gallon drums of solvents such as trichloroethene (TCE) and dichloroethene. The Solvent Storage Area at Building 33 was identified during the IAS. The site was identified as Study Area F in the FFA and is now identified as Site 18 for the **IR** Program. **Groundwater** samples were collected from the site during the **BGOURI** (2002).

At Site 18, no significant **groundwater contamination** was identified during the **BGOURI**. No **groundwater** COPCs were identified for Site 18 during the data screening portion of the **risk assessment**. The results of the **RI** did not indicate that subsequent rounds of investigation were necessary to further characterize the site or that an **FS** was necessary for the site.

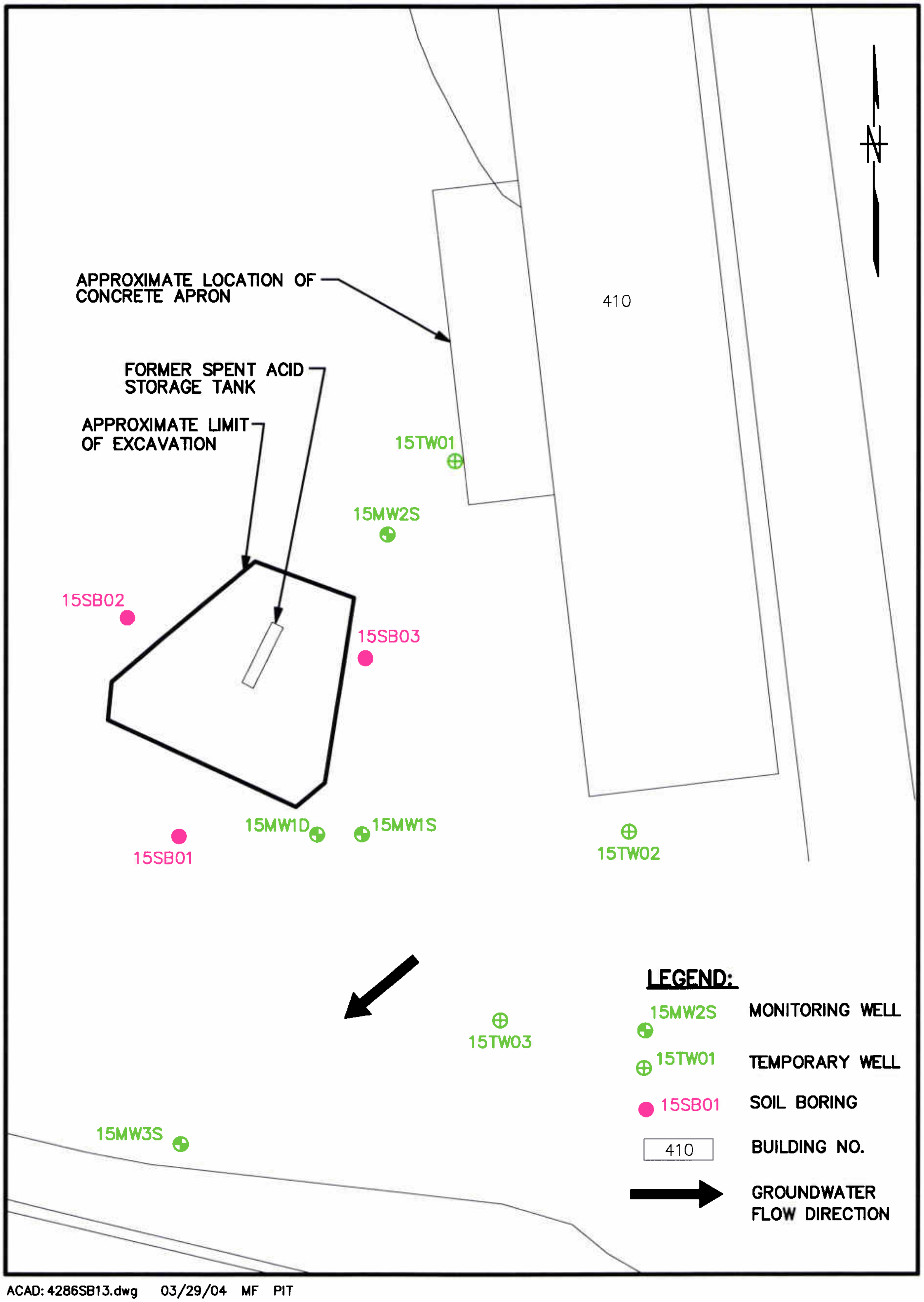


Figure 12. Site 15 Layout Map

The soil associated with Site 18 (**OU**11) was addressed in an NFA **ROD** in 2004.

Site 20

The Area A Weapons Center (Site 20) consists of Building 524 and the weapons storage bunkers. The site is located near the top of a local topographic and bedrock high (Figure 7). Building 524 is used for administration, minor torpedo assembly, and storage of simulator torpedoes. Small quantities of chemicals (cleaning and lubricating compounds, paints, and adhesives) and chemical waste generated by on-site activities are stored at the site. Liquid fuels present in the weapons storage bunkers include **Otto fuel II**, **JP-10**, and **TH Dimer** (jet rocket fuel). A small (less than 200 cubic yards) soil RA was conducted at the site in 2001 to address polynuclear aromatic hydrocarbon (**PAH**) and inorganic **contamination** in the soil and **sediment** (**OU**7). Site 20 soil is designated as **OU**7.

The overburden and bedrock **groundwater** at Site 20 was characterized during three separate investigations. **VOC**s and **SVOC**s were detected sporadically at low concentrations in the overburden and bedrock **groundwater** during the investigations. Naturally occurring **metals** were detected consistently in the **groundwater**. Evaluations of risks in the Phase II **RI** related to the site's **groundwater** indicated potentially unacceptable risks for construction workers and adult residents. The results from the **BGOURI** showed that risks to construction workers were within acceptable levels mainly as a result of lower concentrations of **metals** in **groundwater**. Risks for hypothetical adult residents exceeded acceptable levels in the **BGOURI**. The latest results from the **BGOURI Update/ FS** showed that there are no adverse health effects anticipated from exposure to Site 20 **groundwater** for hypothetical adult residents.

Potential risks resulting from exposures to chemicals that have volatilized from **groundwater** and migrated through building foundations into indoor air were also evaluated in a 2008 memorandum by comparing concentrations of volatile chemicals detected in **groundwater** to USEPA and CTDEP screening criteria for vapor intrusion. Concentrations of trichloroethene exceeded the USEPA screening criterion and it was further evaluated using USEPA's Johnson and Ettinger Vapor Intrusion Model. Modeling results showed that cancer risks and hazard indices for residential and industrial scenarios were within USEPA and CTDEP acceptable levels and vapor intrusion is not an issue at Site 20.

Site 23

Site 23 (Tank Farm) is located in the southern portion of NSB-NLON (Figure 1). Site 23 features nine former USTs that were demolished and closed in place, a 30,000 gallon, doublewalled UST (OT10), a 10,000-gallon waste oil tank, a fuel oil loading area, a tanker truck dumping pad and trough, associated UST piping systems, baseball/ softball fields, buildings that housed the former air sparging/ soil vapor extraction (AS/SVE) facility for the Naval Exchange service station, two 150,000-gallon diesel aboveground storage tank (ASTs), and other buildings. Five of the nine tanks (OT-1, OT-2, OT-3, OT-4, and OT-6) had perimeter underdrains installed around them during their construction to depress **groundwater** levels. In addition, the storm sewers, which the underdrains tie into, were constructed of perforated corrugated metal pipe to help dewater the area. The underdrain at OT-6 was subsequently abandoned around 1966 during completion of improvements to the storm sewer system. The soil at Site 23 was remediated in 1997 and 2000 under the CTDEP Resource Conservation and Recovery Act (RCRA) Underground Storage Tank (UST) Program.

The Site 23 USTs were properly closed in place; however, the tank underdrain systems were allowed to remain in place to help reduce **groundwater** levels in the area. Evidence of releases of petroleum products from the tanks, their associated piping, and possibly from other nearby **sources** was detected in soil during previous investigations. No significant **groundwater contamination** was detected; however, petroleum hydrocarbons were detected periodically at the outfall of the storm sewer system near Goss Cove. The stormwater drainage system was rehabilitated in 2000 such that the original combined **groundwater** and stormwater system was separated into a deep **groundwater** and a new shallow stormwater system. The **groundwater** underdrain system continues to collect **groundwater** from the old tank drains. In 2000, new storm drain was installed using solid wall HDPE piping and much of the underdrain was relined with perforated plastic pipe, at the locations shown on Figure 11. An existing manhole was modified to become a **groundwater** flow-metering and sampling pit. Beyond the metering pit, the **groundwater** underdrain pipe and stormwater collection pipes are recombined (Figure 11), such that **groundwater** then enters the storm sewer system.

The **risk assessment** performed during the **BGOURI** evaluated potential risks from exposures to Site 23 **groundwater** by construction workers and hypothetical adult residents, although, it is unlikely, that direct contact exposures to Site 23 **groundwater** would occur based on current and expected future site use. The results of the **risk**

assessment showed that there are no unacceptable risks to construction workers and hypothetical adult residents.

The Site 23 underdrain metering pit was sampled after construction and quarterly for one year starting in June 2007. The metering pit collects **groundwater** from the Site 23 area underdrains from four former tanks. All relevant concentrations were below established Connecticut criteria with the exception of arsenic and six SVOCs. Arsenic was detected in one unfiltered sample during the September 2007 sampling event at a concentration exceeding the Connecticut criteria, but the concentration of arsenic in the associated filtered sample was below the criteria. Because arsenic was not detected at similar concentrations during previous or subsequent sampling events, it was concluded that the single elevated detection of arsenic was related to suspended solid particles in the water and not a true issue. Six SVOCs were detected during the December 2007 sampling round at concentrations that were greater than the Connecticut surface water protection criteria. These chemicals were not detected in the duplicate sample collected during that round and they were not detected in previous or subsequent sampling events. Therefore, it was concluded that these detections were anomalous.

The **risk assessment** was updated in a 2008 memorandum to account for current **risk assessment** guidance and the 2007/2008 underdrain metering pit quarterly sampling results. The assessment confirmed that risks to construction workers exposed to **groundwater** would be acceptable; however, the assessment showed that there are potential risks to hypothetical residents that would exceed USEPA and CTDEP acceptable levels if **groundwater** is used as a drinking water supply. These risks are mitigated by the fact that many of the major contributors to the carcinogenic and noncarcinogenic risks were only detected in one of four rounds of samples and Site 23 is not suitable for residential development.

Potential risks resulting from exposures to chemicals that have volatilized from **groundwater** and migrated through building foundations into indoor air were also evaluated in a 2008 memorandum by comparing concentrations of volatile chemicals detected in **groundwater** to USEPA and CTDEP screening criteria for vapor intrusion. Concentrations of chloroform and trichloroethene exceeded the USEPA screening criteria and they were further evaluated using USEPA's Johnson and Ettinger Vapor Intrusion Model. Modeling results showed that cancer risks and hazard indices for residential and industrial scenarios were within USEPA and CTDEP acceptable levels and vapor intrusion is not an issue at Site 23.

Based on these results, Site 23 **groundwater** (including Site 9 **groundwater**) collected and conveyed in the storm sewer system does not pose a significant current threat to human health or the environment, but it may pose a potential threat in the future to hypothetical future human receptors if they regularly consume the **groundwater** over a prolonged period of time. **Institutional controls** are required for Site 23 to restrict extraction and use of **groundwater** to minimize the potential risk to future human receptors.

What is Risk and How is it Calculated?

A **human health risk assessment** estimates "baseline risk." This is an estimate of the likelihood of health problems occurring if no cleanup action were taken at a site. To estimate baseline risk at a site, the Navy undertakes a four-step process in accordance with USEPA guidance:

Step 1: Analyze **Contamination**
Step 2: Estimate Exposure
Step 3: Assess Potential Health Dangers
Step 4: Characterize Site Risk

In Step 1, the Navy looks at the concentrations of contaminants found at a site as well as past scientific studies on the effects these contaminants have had on people (or animals, when human studies are unavailable). Comparisons between site-specific concentrations and concentrations reported in past studies help determine which contaminants are most likely to pose the greatest threat to human health.

In Step 2, the Navy considers the different ways that people might be exposed to the contaminants identified in Step 1, the concentrations that people might be exposed to, and the potential frequency and duration of exposure. Using this information, the Navy calculates a "reasonable maximum exposure" (RME) scenario, which portrays the highest level of human exposure that could reasonably be expected to occur.

In Step 3, the Navy uses the information from Step 2 combined with information on the toxicity of each chemical to assess potential health risks. The likelihood of any kind of cancer resulting from exposure to a site is generally expressed as an upper bound probability; for example, a "1 in 10,000 chance." In other words, for every 10,000 people that could be exposed, one extra cancer may occur as a result of exposure to site contaminants. An extra cancer case means that one more person could get cancer than would normally be expected from all other causes. For non-cancer health effects, the Navy calculated a "hazard index," where a "threshold level" (measured usually as a hazard index of less than 1) exists below which non-cancer health effects are no longer predicted.

In Step 4, the Navy determines whether site risks are great enough to cause health problems for people at or near the site. The results of the three previous steps are combined, evaluated, and summarized. The Navy adds the potential risks from the individual contaminants to determine the total risk resulting from the site. The following table summarizes cancer and non-cancer risks for all OU9 Sites:

Table 1: Summary of Cancer Risks and Hazard Indices

	Site 2A	Site 2B	Site 3	Site 7
Construction Workers – Direct Exposure				
Cancer Risk	1.2 per 100,000,000	3.3 per 100,000,000	1.3 per 1,000,000	4.2 per 10,000,000
Hazard Index	0.006	0.2	0.001	0.09
Adult Residents – Direct Exposure				
Cancer Risk	3.3 per 10,000	NA	1.4 per 1000	6.4 per 10,000
Hazard Index	6.4	NA	2.4	5.6
Industrial Workers – Vapor Intrusion				
Cancer Risk	1.1 per 1,000,000,000	1.4 per 100,000,000	2.3 per 1,000,000	6.2 per 1,000,000,000
Hazard Index	0.000003	0.00003	0.01	0.00001
Adult Residents – Vapor Intrusion				
Cancer Risk	7.8 per 1,000,000,000	9.8 per 100,000,000	1.6 per 100,000	4.2 per 100,000,000
Hazard Index	0.00002	0.0001	0.06	0.00008

	Site 15	Sites 14 & 18	Site 20	Sites 9 & 23
Construction Workers – Direct Exposure				
Cancer Risk	No COPCs	No COPCs	1.1 per 10,000,000	8.8 per 100,000,000
Hazard Index	0.002	No COPCs	0.0002	0.2
Adult Residents – Direct Exposure				
Cancer Risk	No COPCs	No COPCs	5.6 per 100,000	2.6 per 10,000
Hazard Index	0.3	No COPCs	0.3	13
Industrial Workers – Vapor Intrusion				
Cancer Risk	5.1 per 10,000,000	No COPCs	1.1 per 100,000,000	3.4 per 10,000,000
Hazard Index	0.001	No COPCs	0.00003	0.0008
Adult Residents – Vapor Intrusion				
Cancer Risk	3.5 per 1,000,000	No COPCs	7.4 per 100,000,000	2.3 per 1,000,000
Hazard Index	0.007	No COPCs	0.0001	0.005

NA - Not applicable. A residential scenario was not evaluated since Site 2B is a wetland.

No COPCs - Maximum concentrations of all chemicals were less than the screening criteria; therefore, no evaluation was required.

Summary of Alternatives Considered for OU9

The Navy prepared **FS**s to evaluate remedial alternatives for the **groundwater** at Sites 3 and 7 and risk evaluations and alternative evaluations were included in the **ROD** to evaluate **groundwater** at Sites 9 and 23. **FS**s were not prepared for Sites 14, 15, 18, or 20 because there were no actionable risks under CERCLA (see Table 1). **Groundwater** at Sites 2A and 2B is currently monitored under a **groundwater monitoring** program selected as part of the remedy for **OU**1.

Sites 3 and 7

For Sites 3 and 7, the Navy prepared an **FS** that involved development and evaluation of alternatives that would address the COCs detected exclusively at Site 3 (vinyl chloride) and the COCs detected at both Sites 3 and 7 (TCE and hexachlorobenzene). The Navy prepared a second **FS** that involved preparation and evaluation of alternatives that addressed the COCs detected exclusively at Site 7 (1,4-dichlorobenzene, benzene, and chlorobenzene). The alternatives evaluated in the two **FS**s are described separately below.

The two alternatives evaluated in the **FS** for combined Sites 3 and 7 **groundwater** included Alternative GW1-1 (No Action) and Alternative GW1-2 (**Institutional Controls** with **Monitoring**). These alternatives were presented in the 2004 Proposed Plan. Active **groundwater** remedial technologies were evaluated but not retained for alternative development because of the absence of a contaminant plume. Alternative GW1-1 was evaluated for comparison purposes, and Alternative GW1-2 was evaluated because of site conditions (generally low concentrations of contaminants, **groundwater** not classified as a suitable potable water **source**, and the availability and use of a public water supply) and its ability to meet the Remedial Action Objectives (RAOs). The RAOs as defined in the **FS** and amended based on recent **groundwater** data are: (1) to protect current receptors (construction workers) from incidental exposure to contaminated **groundwater**, (2) to protect potential future receptors from exposure to contaminated **groundwater** via ingestion (potable water supply and vapor intrusion), and (3) to protect aquatic ecological receptors. The following table summarizes the remedial alternatives considered in the **FS**. Estimated costs are presented including capital, operation and maintenance (O&M), and total present worth costs.

Table 2: Remedial Alternatives Considered for Sites 3 and 7, Area A Downstream Watercourses and the Torpedo Shops

Remedial Alternatives	Components	Comments
Alternative GW1-1: **No Action**	None, except mandatory five-year site reviews.	This alternative is not expected to be fully protective of human health and the environment because of unrestricted access to contaminated **groundwater**. Total Cost = $89,600 (30 years)
Alternative GW1-2: **Monitoring and Institutional Controls**	Continue to implement existing **institutional controls** that identify the location and magnitude of **groundwater contamination** and restrict extraction and use of **groundwater**. Amend existing **institutional controls** to address vapor intrusion. Continue to monitor **groundwater** contaminants. Conduct five-year site reviews.	Under this alternative, human health and the environment would be protected through **institutional controls** that identify the location and magnitude of **groundwater contamination** , address vapor intrusion, and restrict extraction and use of **groundwater** and through **monitoring** of the **groundwater** contaminants at the site. Total Cost = $319,500 (30 years)

The three alternatives evaluated in the **FS** for Site 7 **groundwater** included Alternative GW2-1 (No Action), Alternative GW2-2 (**Institutional Controls** with **Monitoring**), and Alternative GW2-3 (Extraction and Off-Site Discharge). Alternative GW2-1 was evaluated for comparison purposes, and Alternatives GW2-2 and GW2-3 were evaluated because of site conditions and their ability to meet the RAOs. The RAOs for this **FS** were (1) to protect current receptors (construction workers) from incidental exposure to contaminated **groundwater**, (2) to protect potential future receptors from exposure to contaminated **groundwater** via ingestion (potable water supply), and (3) to protect aquatic ecological receptors. Table 3 summarizes the remedial alternatives considered in the Site 7 **groundwater FS**.

The proposed remedial actions for **groundwater** at Sites 3 and 7 were previously presented in the September 2004 Proposed Plan and December 2004 Interim **ROD**. Based on the interim selected remedy of **institutional controls** and **groundwater monitoring** for Sites 3 and 7, a **groundwater monitoring** program for Sites 3 and 7 was initiated in 2006. Also, a remedial design for land use controls was completed in 2005 and the Navy instruction document that defines the Navy's policy regarding disturbance of soil and **groundwater** at IR sites was updated in 2006 to include Sites 3 and 7 **groundwater**. The document will need to be updated to include the restrictions for vapor intrusion at Site 3.

The two alternatives evaluated for Sites 9 and 23 **groundwater** included Alternative GW3-1 (No Action) and Alternative GW3-2 (**Institutional Controls**). Active **groundwater** remedial technologies were not evaluated because of the absence of a contaminant plume and other site conditions (generally low concentrations of contaminants, **groundwater** not classified as a suitable potable water **source**, and the availability and use of a public water supply). Alternative GW1-1 was evaluated for comparison purposes and Alternative GW1-2 was evaluated because of site conditions and its ability to meet the Remedial Action Objectives (RAOs). The RAOs as defined in the **ROD** are: (1) to protect potential future receptors from exposure to contaminated **groundwater** via ingestion (potable water supply and vapor intrusion), and (2) to protect aquatic ecological receptors. Table 4 summarizes the remedial alternatives that were considered. Estimated costs are presented including capital, operation and maintenance (O&M), and total present worth costs.

Alternatives Evaluation Criteria

The following is a summary of the nine Superfund-mandated criteria used to balance the pros and cons of the remedial alternatives. The **FS** alternatives were evaluated using the first seven criteria. After comments from the State of Connecticut and public are received, the alternatives will be compared using the last two criteria to select the remedies for Sites 3 and 7 **groundwater**.

Table 3: Remedial Alternatives Considered for Site 7, the Torpedo Shops

Remedial Alternatives	Components	Comments
Alternative GW2-1: **No Action**	None, except mandatory five-year site reviews.	This alternative is not expected to be fully protective of human health and the environment because of unrestricted access to contaminated **groundwater**. Total Cost = $89,600 (30 years)
Alternative GW2-2: **Monitoring and Institutional Controls**	Continue to implement **institutional controls** that identify the location and magnitude of **groundwater contamination** and restrict extraction and use of **groundwater**. Continue to monitor the **groundwater**. Conduct five-year site reviews.	Under this alternative, human health and the environment would be protected through **institutional controls** that identify the location and magnitude of **groundwater contamination** and restrict extraction and use of **groundwater** and through **monitoring groundwater** contaminants at the site. Total Cost = $303,800 (30 years)
Alternative GW2-3: **Extraction and Offsite Discharge**	Install **groundwater** extraction and **monitoring** system. Extract approximately 1,250,000 gallons of **groundwater** over nearly 8 months. Pretreat extracted **groundwater**, if necessary, and discharge water to Publicly-Owned Treatment Works. Perform **monitoring** to confirm achievement of the remedial goals. Decommission the extraction system and restore the site to its original conditions.	Under this alternative, human health and the environment would be protected since the contaminated **groundwater** would be extracted from the site, treated as necessary, and discharged. Total Costs = $1,121,000 (1.5 years)

Table 4: Remedial Alternatives Considered for Sites 9 and 23, Tank Farm

Remedial Alternatives	Components	Comments
Alternative GW3-1: **No Action**	None, except mandatory five-year site reviews.	This alternative is not expected to be fully protective of human health and the environment because of unrestricted access to contaminated **groundwater**. Total Cost = $89,600 (30 years)
Alternative GW3-2: **Institutional Controls**	Implement **institutional controls** that identify the location and magnitude of **groundwater contamination** and restrict extraction and use of **groundwater**. Conduct five-year site reviews.	Under this alternative, human health and the environment would be protected through **institutional controls** that identify the location and magnitude of **groundwater contamination**, and restrict extraction and use of **groundwater**. Total Cost = $119,000 (30 years)

1. Overall protection of human health and the environment: The alternative should protect human health as well as plant and animal life on and near the site.

2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs): The alternative should meet applicable and relevant and appropriate federal environmental statutes, regulations, and requirements and State environmental and facility siting statutes, regulations, and requirements.

3. Long-term effectiveness and permanence: The alternative should maintain reliable protection of human health and the environment over time.

4. Reduction of toxicity, mobility, or volume through treatment: CERCLA prefers that the selected alternative use treatment to permanently reduce the level of toxicity of contaminants at the site, the spread of contaminants away from the **source** of **contamination**, or the amount of **contamination** at the site.

5. Short-term effectiveness: The alternative should minimize short-term hazards to workers, residents, or the environment during implementation of the remedy.

6. Implementability: The alternative should be technically feasible, and the materials and services needed to implement the remedy should be readily available.

7. Cost: Capital costs, annual operation and maintenance costs, and their associated net present values of all alternatives retained for detailed analysis shall be compared.

8. State acceptance: The State environmental agencies should agree with the proposed remedy.

9. Community acceptance: The community should agree with the proposed remedy. Community acceptance is based on comments received during the public comment period.

The Proposed Remedies

Sites 3 and 7

The Navy reviewed the results of the two **FS**s and decided that it was appropriate to select one remedial alternative that could address **groundwater contamination** found in the portion of **OU**9 associated with Sites 3 and 7. The proposed alternative **Institutional Controls** with **Monitoring**. This alternative was selected in the 2004 Interim **ROD**. The alternative meets all of the RAOs by restricting access to and use of contaminated **groundwater** and **monitoring** the **groundwater** at the site. This remedial alternative has three major components: (1) implement **institutional controls** at the sites, (2) conduct a comprehensive **monitoring** program to ensure that the remedial goals are met and the resulting concentrations are shown to be protective of human health and the environment, and to verify that **groundwater** contaminants are not migrating and impacting other resources, and (3) complete 5-year reviews of the site until the remedial goals are consistently reached. The components of the alternative are discussed in more detail below.

- Implementation of **institutional controls** at the sites involved identifying the location, magnitude, and type of **contamination** and documenting it in a remedial design for land use controls and the **NSB-NLON IR Site Use Restrictions document**. These documents present the land use control objectives and include specific drawings and instructions for Navy personnel so that contaminated **groundwater** would not be extracted or used in a manner that would threaten human

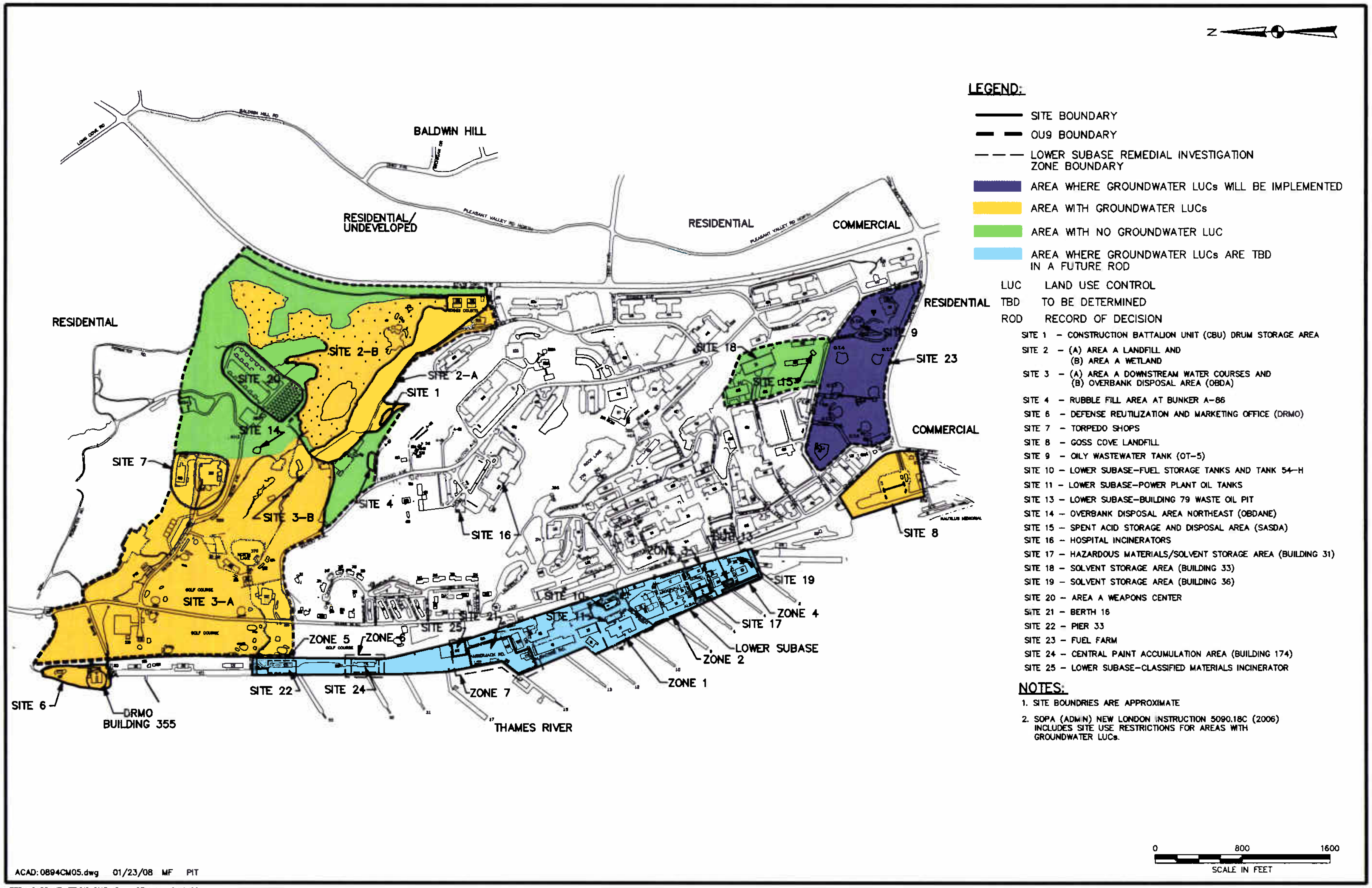


Figure 13. Location of Basewide Groundwater Operable Unit 9 and Areas with Groundwater Land Use Controls

health or the environment. Figure 13 shows the areas of Sites 3 and 7 that have **groundwater** land use controls. Areas of NSB-NLON with soil land use controls are shown on Figure 14. In the event of property transfer, and with confirmation that contaminated **groundwater** remains at the site, an environmental land use restriction pursuant to State law will be used to prohibit the use of **groundwater**. The **institutional controls** will also be amended to state that additional evaluation or the installation of mitigation measures relating to vapor intrusion will be implemented if future construction takes place.

- A **groundwater monitoring** plan has been developed to document the details of the **monitoring** program. Eight additional **monitoring** wells were installed and used in conjunction with previously existing **monitoring** wells to create the **monitoring** well network required for the Sites 3 and 7 **monitoring** program. During each sampling event all wells within the **monitoring** network will be sampled. Initially, sampling events will occur quarterly. Sampling frequency could be reduced after sufficient data are acquired and contaminant concentrations have diminished. Based on the contaminants at the sites, it is possible that **monitoring** activities will be required for decades until the remedial goals are reached and the resulting concentrations are shown to be protective of human health and the environment. It is expected that contaminants present in **groundwater** will continue to trend downward and will shortly be below the remedial goals.

- Five-year reviews will be conducted for Sites 3 and 7 **groundwater** as required under CERCLA until the **monitoring** program shows that the remedial goals have been reached. The goal of conducting the site reviews is to verify that no changes have occurred that would impact the protectiveness of the selected remedy.

It is Navy's and EPA's current judgment that the Preferred Alternative for Sites 3 and 7 identified in this Proposed Plan is necessary to protect public health, welfare, and the environment from actual or threatened releases of pollutants or contaminants in the **groundwater** at Sites 3 and 7 because they may present an imminent and substantial endangerment to public health or welfare.

Sites 9 and 23

The Navy reviewed the results of the evaluations and decided that it was appropriate to select one remedial alternative that could address **groundwater contamination** found in the portion of **OU**9 associated with Sites 9 and 23. The proposed alternative is Alternative 3-2 **Institutional Controls**. The alternative meets all of the RAOs by restricting access to and use of contaminated **groundwater**. This remedial alternative has two major components: (1) implement **institutional controls** at the site and (2) complete 5-year reviews of the site. The components of the alternative are discussed in more detail below.

- Implementation of **institutional controls** at the site involves identifying the location, magnitude, and type of **contamination** and documenting it in a remedial design for land use controls and the **NSB-NLON IR Site Use Restrictions document**. These documents present the land use control objectives and include specific drawings and instructions for Navy personnel so that contaminated **groundwater** would not be extracted or used in a manner that would threaten human health or the environment. Figure 13 shows the areas of Sites 9 and 23 that have **groundwater** land use controls. Areas of NSB-NLON with soil land use controls are shown on Figure 14. In the event of property transfer, and with confirmation that contaminated **groundwater** remains at the site, an environmental land use restriction pursuant to State law will be used to prohibit the use of **groundwater**.

- Five-year reviews will be conducted for Sites 9 and 23 **groundwater** as required under CERCLA. The goal of conducting the site reviews is to verify that no changes have occurred that would impact the protectiveness of the selected remedy.

It is the Navy's and EPA's current judgment that the Preferred Alternative for Sites 9 and 23 identified in this Proposed Plan is necessary to protect public health, welfare, and the environment from actual or threatened releases of pollutants or contaminants in the **groundwater** at Sites 9 and 23 because they may present an imminent and substantial endangerment to public health or welfare.

Sites 2A and 2B

Groundwater at Sites 2A and 2B is currently monitored under a **groundwater monitoring** program selected as part of the remedy for **OU**1. Post-closure **groundwater** monitoring is required by the September 2005 **ROD**. Volumes II and III of the Operation and Maintenance Manual for Installation Restoration Program Sites at Naval Submarine Base New London (January 2006) describe the **groundwater** monitoring plan in detail. This Plan proposes to continue that monitoring for Site 2A. **Institu-**

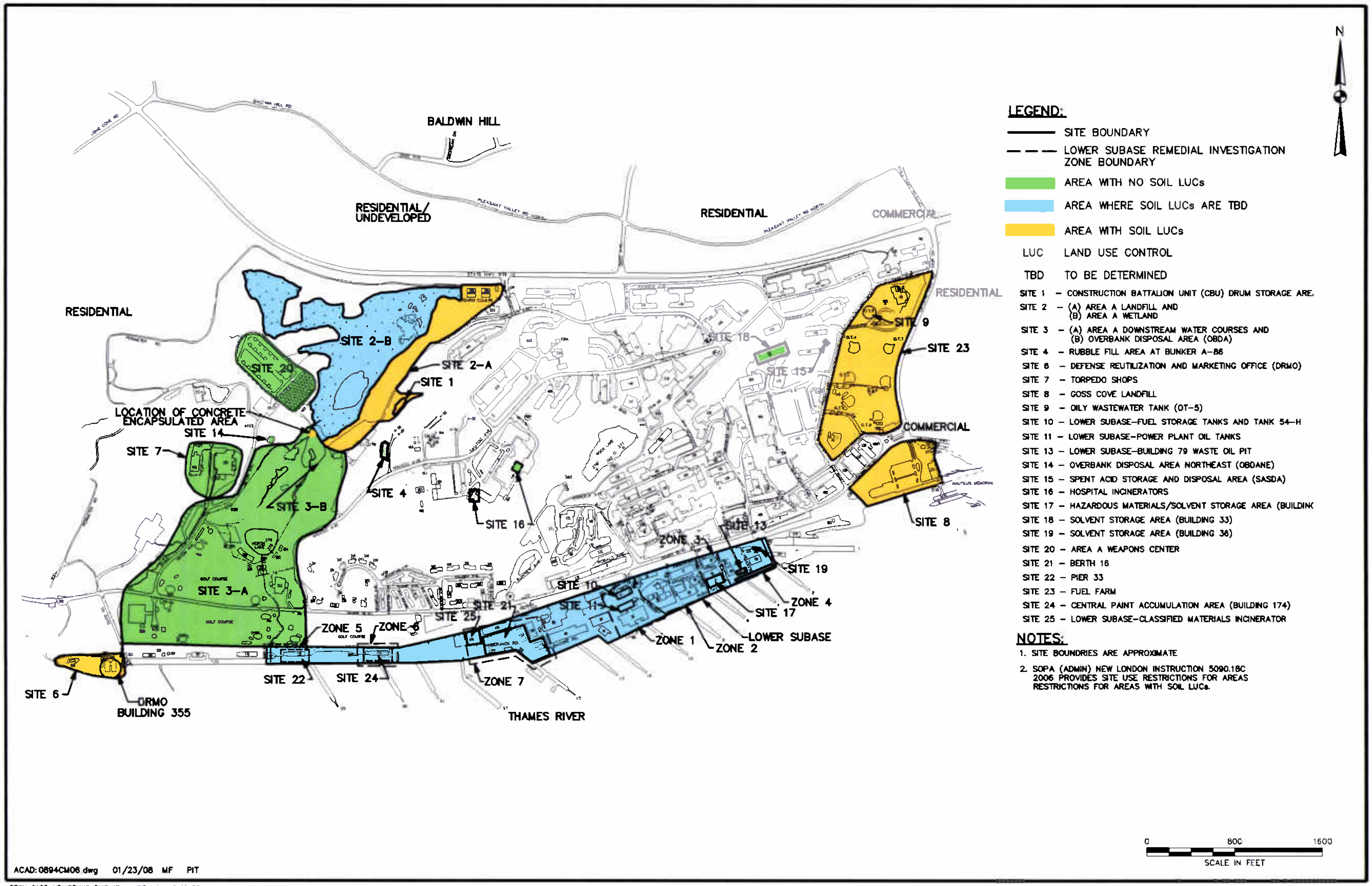


Figure 14. Location of Areas at NSB-NLON with Soil Land Use Controls

tional controls will remain in place at Site 2A and are described in the **Site Use Restrictions document**.

Sites 14, 15, 18, and 20

The Navy and EPA have determined that No Further Action is necessary for the **groundwater** at Sites 14, 15, 18, and 20 to protect public health or welfare or the environment.

Concluding Summary

Based on information currently available, the Navy believes the Preferred Alternatives meet the threshold criteria and provide the best balance of tradeoffs among the other alternatives with respect to balancing and modifying criteria. The Navy expects the Preferred Alternatives to satisfy the following statutory requirements of CERCLA §112(b): (a) be protective of human health and the environment; (b) comply with **ARARs**; (c) be cost-effective; (d) use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and (e) satisfy the preference for treatment as a principal element or explain why the preference for treatment will not be met.

The CTDEP concurs with the proposed remedies.

The Public's Role in Alternative Selection

Community input is integral to the selection process. The Navy and regulatory agencies will consider all comments in selecting the remedial actions before signing the **ROD**. The public is encouraged to participate in the decision-making process. This Proposed Plan for Basewide **Groundwater OU**9 is available for review, along with supplemental documentation, at the following Information Repositories:

Groton Public Library 52 Newtown Road Groton, CT 06340 (860) 441-6750	Hours: Mon.-Thurs.: 9:00 am-9:00 pm Fri.: 9:00 am - 5:30 pm Sat.: 9:00 am - 5:00 pm Sun.: Noon - 5:00 pm
Bill Library 718 Colonel Ledyard Highway Ledyard, CT 06339 (860) 464-9912	Hours: Mon.-Thur.: 9:00 am-9:00 pm Fri. & Sat.: 9:00 am - 5:00 pm Sun.: 1:00 pm - 5:00 pm

For further information, please contact:

Ron Pinkoski, Remedial Project Manager
NAVFAC MIDLANT OPNEEV
Environmental Restoration
Building Z-144
9742 Maryland Avenue
Norfolk, VA 23511-3095
Tel (757) 444-0735
Email: ronald.pinkoski@navy.mil

Richard Conant, IR Program Manager
Naval Submarine Base-New London
Bldg. 439, Box 101, Room 104
Route 12
Groton, CT 06349
Tel: (860) 694-5649
Email: richard.conant@navy.mil

Kymberlee Keckler, Remedial Project Manager
U. S. Environmental Protection Agency, Region 1
Federal Facilities Superfund Section
1 Congress Street (HBT)
Boston, MA 02114-2023
Tel: (617) 918-1385
Email: keckler.kymberlee@epa.gov

Mark Lewis, Environmental Analyst 3
Connecticut Department of Environmental Protection
Eastern District Remediation Program, Remediation Division
Bureau of Water Protection and Land Reuse
79 Elm Street
Hartford, CT 06106-5127
Tel: (860) 424-3768
e-mail: mark.lewis@ct.gov

Glossary of Technical Terms

Applicable or Relevant and Appropriate Requirements (ARARs): The federal environmental rules, regulations, and criteria and State environmental and facility siting statutes, regulations, and requirements that must be met by the selected remedy under Superfund.

Basewide Groundwater Operable Unit Remedial Investigation (BGOURI) Update/Feasibility Study (FS): A Remedial Investigation report describes the site, documents the nature and extent of **contaminants** detected at the site, and presents the results of the **risk assessment**. An **FS** report presents the development, analysis, and comparison of remedial alternatives.

Contamination: Any physical, biological, or radiological substance or matter that, at a certain concentration, could have an adverse effect on human health and the environment.

Groundwater: Water found beneath the earth's surface in the pores of the soil or the cracks in the bedrock. **Groundwater** may transport substances that have percolated downward from the ground surface as it flows towards its point of discharge.

Installation Restoration (IR) Program: The purpose of the program is to identify, investigate, assess, characterize, and clean up or control releases of hazardous substances, and to reduce the risk to human health and the environment from past waste disposal operations and hazardous material spills at Navy activities in a cost-effective manner.

Institutional Controls: Engineered or physical controls and/or administrative or legal mechanisms designated to protect public health and the environment from contamination.

JP-10: A popular missile fuel that is a single-component hydrocarbon (C10H16), rather than a mixture of many hydrocarbons. **JP-10** fuel is a storable liquid.

Metals: Metals are naturally occurring elements in the earth. Some **metals**, such as arsenic and mercury, can have toxic effects. Other **metals**, such as iron, are essential to the metabolism of humans and animals.

Micrograms per Liter (µg/L): One part of contaminant in a billion parts of water.

Monitoring: Collection of environmental information that helps to track changes in the magnitude and extent of **contamination** at a site or in the environment.

Operable Unit (OU): Contaminated media, site, or set of sites that are evaluated as a group.

Otto Fuel II: **Otto Fuel II** is a distinct-smelling, reddish-orange, oily liquid that produces hydrogen cyanide when burned. The U.S. Navy uses **Otto Fuel II** as a fuel for torpedoes and other weapon systems. It is a mixture of three synthetic substances: propylene glycol dinitrate (the major component), 2-nitrodiphenylamine, and dibutyl sebacate.

Polynuclear Aromatic Hydrocarbons (PAHs): High molecular weight, relatively immobile, and moderately toxic organic chemicals featuring multiple benzenic (aromatic) rings in their chemical formula. Typical examples of **PAHs** are naphthalene and phenanthrene.

Potentiometric Contours: Contours that represent the height (usually above sea level) at which the water level stands in tightly cased wells that penetrate the aquifer. Potentiometric contours define a surface that is equivalent to the water table in an unconfined aquifer.

Record of Decision (ROD): An official document that describes the selected Superfund remedy for a site. The **ROD** documents the remedy selection process and is issued by the Navy and USEPA following the public comment period on the Proposed Plan.

Remedial Investigation (RI): A report that describes the site, documents the nature and extent of contaminants detected at the site, and presents the results of the **risk assessment**.

Responsiveness Summary: A summary of written and oral comments received during the public comment period, together with the Navy's and USEPA's responses to these comments.

Risk Assessment: Evaluation and estimation of the current and future potential for adverse human health or environmental effects from exposure to contaminants.

Sediment: Soil, sand, and minerals typically transported by erosion from soil to the bottom of surface water bodies such as streams, rivers, ponds, and lakes.

Site Use Restrictions Document: SOPA (ADMIN) New London Installation 5090.18C, Installation Restoration Site Use Restrictions at Naval Submarine Base New London defines Navy policy and procedures regarding disturbance of contaminated soils/sediments and/or extraction of contaminated groundwater. The locations of impacted media are also identified in figures provided in the Instruction.

Semi-Volatile Organic Compound (SVOC): Carbon-based chemical compounds that have low vapor pressures and only evaporate at elevated temperatures. **PAHs** are examples of **SVOC**s.

Source(s): Area(s) of a site where **contamination** originated.

TH Dimer: Tetrahydromethylcyclopentadiene, also called RJ-4, is a missile fuel which is used alone or as a component of JP-9 jet fuel.

Volatile Organic Compound (VOC): Carbon-based chemical compounds that have high vapor pressures and evaporate readily at normal temperatures. Examples of **VOC**s are the components of gasoline (*i.e.*, benzene, toluene, ethylbenzene, and xylenes) and solvents (*e.g.*, TCE).

USE THIS SPACE TO WRITE YOUR COMMENTS

Your input on the Proposed Plan for the Basewide **Groundwater OU**9 at Naval Submarine Base – New London is important to the Navy and EPA. Comments provided by the public are valuable in helping to select the remedies for **groundwater** at these sites.

You may use the space below to write your comments, then fold and mail. Comments must be postmarked by July 14, 2008. Comments can be submitted via mail or e-mail and should be sent to either of the following addresses:

Ron Pinkoski, Remedial Project Manager
NAVFAC MIDLANT OPNEEV
Environmental Restoration
Building Z-144
9742 Maryland Avenue
Norfolk, VA 23511-3095
Tel (757) 444-0735
Email: ronald.pinkoski@navy.mil

Richard Conant
IR Program Manager
Naval Submarine Base - New London
Bldg. 439, Box 101, Room 104
Route 12
Groton, CT 06349-5039
Tel: (860) 694-5649
Email: richard.conant@navy.mil

If you have any questions about the proposed remedies or the comment procedures please contact Mr. Ron Pinkoski at (757) 444-0735.

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Name ____________________

Address ____________________

City ____________________

State __________ Zip __________

Telephone ____________________

Richard Conant
IR Program Manager
Naval Submarine Base - New London
Bldg. 439, Box 101, Room 104
Route 12
Groton, CT 06349-5039

PUBLIC NOTICE

PUBLISHER'S CERTIFICATE

State of Connecticut
County of New London, ss. New London

Personally appeared before the undersigned, a Notary Public within and for said County and State, Melanie Foley, Legal Adverising Clerk, of The Day Publishing Company Classifieds dept, a newspaper published at New London, County of New London, state of Connecticut who being duly sworn, states on oath, that the Order of Notice in the case of

6198 PUBLIC NOTICE The Department of the Navy, Naval Sub

A true copy of which is hereunto annexed, was published in said newspaper in its issue(s) of

06/14/2008

Cust: TETRA TECH NUS, INC.
Ad #: d00128017

Melanie Foley

Subscribed and sworn to before me

This Friday, June 13, 2008

Lorraine Merten

Notary Public

My commission expires 9-30-2008

6198

PUBLIC NOTICE

The Department of the Navy, Naval Submarine Base New
London (NSB-NLON), in conjunction with the United
States Environmental Protection Agency and the Con-
necticut Department of Environmental Protection, will
hold a public meeting and hearing to present the Pro-
posed Plan under the Comprehensive Environmental Re-
sponse, Compensation, and Liability Act (CERCLA) for
final remedial actions for the groundwater at Sites 2A,
2B, 3, 7, 9, 14, 15, 18, 20, and 23. The groundwater at these
sites has been designated as Operable Unit (OU) 9.

The proposed remedial actions for groundwater at Sites
3, 7, 14, 15, 18, and 20 were previously presented in a 2004
Proposed Plan and Interim Record of Decision (ROD).
The proposed remedial actions for groundwater at those
sites were considered interim actions in 2004 because the
remaining portions of OU9 (Sites 2A, 2B, 9 and 23) were
not addressed at that time. In this Proposed Plan, reme-
dial actions are proposed for all portions of OU9 (Sites
2A, 2B, 3, 7, 9, 14, 15, 18, 20, and 23 groundwater), and
this will be the final Proposed Plan for OU9.

This Proposed Plan recommends final measures of insti-
tutional controls and monitoring for groundwater at Sites
3 and 7. This recommendation is based on recent moni-
toring results in conjunction with the Basewide Ground-
water Operable Unit Remedial Investigation (BGOURI)
Update Report's conclusion that there were no significant
risks to current human or ecological receptors, but there
are potentially significant risks to hypothetical residents
from routine, long-term consumption of contaminated
groundwater. This remedy will be protective of human
health and the environment.

This Proposed Plan recommends final measures of insti-
tutional controls for groundwater at Sites 9 and 23. This
recommendation is based on recent monitoring results in
conjunction with the 2008 risk memorandum conclusion
that there were no significant risks to current human or
ecological receptors, but there are potentially significant
risks to hypothetical residents from routine, long-term
consumption of contaminated groundwater. This reme-
dy will be protective of human health and the environ-
ment.

This Proposed Plan also recommends no further action
for groundwater at Sites 14, 15, 18, and 20. Various stud-
ies at Sites 14, 15, 18, and 20 determined that there were
no significant risks to human health or the environment
from current or future exposure to groundwater at these
sites.

Studies at Sites 2A and 2B have shown that there are no
significant risks to human health and the environment
from current exposure to groundwater. In addition, a
compliance groundwater monitoring program is current-
ly being conducted at Sites 2A and 2B under the OU1
ROD. Therefore, no additional action is required for
groundwater at these two sites under OU9.

Although this is presently the preferred final remedy for
OU9, the Navy welcomes the public's input. A public
meeting and hearing will be held on Thursday, June 26,
2008, at 6:30 p.m. at the Best Western Olympic Inn locat-
ed at 360 Route 12, Groton, Connecticut. The public is en-
couraged to attend this meeting and hearing to ask ques-
tions and to provide verbal comments to the Navy on the
remedy recommended in the Proposed Plan. Comments
made at the public hearing will be transcribed, and a
copy of the transcript will be added to the Administra-
tive Record for NSB-NLON. Complete documentation for
the subject sites, including detailed site descriptions, are
provided in the Phase II Remedial Investigation (RI),
BGOURI Report, BGOURI Update/Feasibility Study
(FS) Report, Year 1 Annual Groundwater Monitoring Re-
port for Sites 3 and 7, Second Five-Year Review Report,
Interim ROD, and the entire Administrative Record file
for NSB-NLON, are available for review at the following
Information Repositories:

Groton Public Library
52 Newton Road
Groton, CT 06340
Hours:
Mon. - Thurs. 9:00 a.m. - 9:00 p.m.
Fri. 9:00 a.m. - 5:30 p.m.
Sat. 9:00 a.m. - 5:00 p.m.
Sun. Noon - 5:00 p.m.
(860) 441-6750

Bill Library
718 Colonel Ledyard Highway
Ledyard, CT 06339
Hours:
Mon.-Thurs. 9:00 a.m. - 9:00 p.m.
Fri. & Sat. 9:00 a.m. - 5:00 p.m.
Sun. 1:00 p.m. - 5:00 p.m.
(860) 464-9912

For further information, please contact any of the follow-
ing individuals:

Richard Conant
Installation Restoration Program Manager
Naval Submarine Base New London
Bldg. 439, Box 101, Room 104
Route 12
Groton, CT 06349-5039
Tel.: (860) 694-5649
Email: richard.conant@navy.mil

Ron Pinkoski
Remedial Project Manager
NAVFAC MIDLANT/OPNEEV
Environmental Restoration
Building Z-144
9742 Maryland Avenue
Norfolk, VA 23511-3095
Tel. (757) 444-0735
Email: ronald.pinkoski@navy.mil

Kymberlee Keckler
Remedial Project Manager
U. S. Environmental Protection Agency, Region 1
1 Congress Street
Suite 1100 (HBT)
Boston, MA 02114-2023
Tel. (617) 918-1385
Email: keckler.kymberlee@epa.gov

Mark Lewis
Environmental Analyst 3
Connecticut Department of Environmental Protection
Eastern District Remediation Program
Remediation Division
Bureau of Water Protection and Land Reuse
79 Elm Street
Hartford, CT 06106-5127
Tel. (860) 424-3768
Email: mark.lewis@po.state.ct.us

APPENDIX D

PUBLIC MEETING TRANSCRIPT

PROPOSED PLAN FOR BASE-WIDE GROUNDWATER OPERABLE

UNIT 9

SITES 2, 3, 7, 9, 14, 15, 18, 20, AND 23

Public Meeting regarding the Naval Submarine Base - New London taken at the Best Western Olympic Inn, Route 12, Groton, Connecticut, before Clifford Edwards, LSR, Connecticut License No. SHR.407, a Professional Shorthand Reporter and Notary Public, in and for the State of Connecticut on June 26, 2008, at 6:35 p.m.

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A P P E A R A N C E S:

COREY RICH
TETRA TECH NUS, INC.
Foster Plaza 7
661 Andersen Drive
Pittsburgh, Pennsylvania 15220
412.921.4040, f: 412.921.8984
Corey.Rich@TetraTech.com

RICHARD CONANT
IR PROGRAM MANAGER
NAVAL SUBMARINE BASE - NEW LONDON
Building 439, Box 101, Room 104
Route 12
Groton, Connecticut 06349
860.694.5649
Richard.Conant@Navy.mil

KYMBERLEE KECKLER
REMEDIAL PROJECT MANAGER
U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION 1
Federal Facilities Superfund Section
1 Congress Street
Boston, Massachusetts 02114
617.918.1385
Keckler.Kymberlee@EPA.gov

A P P E A R A N C E S (CONTINUED):

ALSO PRESENT:

Val Jurka

Noah Levine

Linda Levine

Mark Oefinger

Felix Prokopf

Ron Pinkoski

Mark Lewis

Chris Zendan

Larry Gibson

Harry Watson

Andrew Stackpole

RICHARD CONANT: Thank you, everyone, for showing up. I think all of you know me, Richard Conant. I'm with the NAVFAC Public Works Environmental Division now.

We are no longer a separate compartment at the base, but we're still on the base. Tonight, we're going to be presenting our proposed plan for the base water/ground water operable unit 9 or 10 sites.

Depending on how you want the count, that's 9 up there. But sometimes we break Site 2 and into 2-A and 2-B.

We will start off, Corey, our contractor, Navy contractor, will be presenting the proposed plan here during the meeting and then immediately go into a public hearing.

If anyone would like to make a comment, have any questions, please present those. You certainly can present written comments to us during the public notice period which started -- Corey, July --

COREY RICH: June 14.

RICHARD CONANT: -- June 14th and closes down July --

COREY RICH: -- 14.

RICHARD CONANT: -- 14th.

And after that we will incorporate any comments into a ROD that will be out and reviewed by the regulators, and eventually we will finalize that ROD --

Hey, you are missing the best part here.

Before ever we get into this, I'd like to introduce our new RPM, remedial program manager.

Ron, please stand up and introduce yourself.

RON PINKOSKI: Ron Pinkoski, also with NAVFAC, but I'm located at Naval Station Norfolk.

But I'm the program manager for the cleanup here at New London.

RICHARD CONANT: It's great to have Ron here.

He brings a lot of experience over

from the army.

RON PINKOSKI: The army.

RICHARD CONANT: I've been saying the air force for months now.

I finally got that right. But BRAC chased him out of the army. He's with the Navy now. So it's great to have him on board.

And Val Jurka I think you know is our former RPM is still with us. He's gone over to more technical capacity.

But I think we'll be seeing his face here and his involvement with the program here as I think we get into a very intense and exciting period as we -- I hesitate to say wrap things up.

But over the next two or three years I think we've made a lot of progress. Hopefully Kymberlee and Mark will shake their head, yes.

KYMBERLEE KECKLER: Yes.

RICHARD CONANT: We do have -- certainly, this we're wrapping up the Area A Wetland, I think is the next site that's really in the barrel.

And then, we save the best for last, lower base which is going to be a very complex, very complicated, very exacting site to deal with. But we'll get there.

We are well into a FS/feasibility study on that. But not to get into that, our focus is with the ground water, OU.

Go ahead, Corey.

COREY RICH: All right. Thanks.

Again, my name is Corey Rich with Tetra Tech NUS, consultant for the Navy.

Before I get started, there's three handouts in the back if people didn't pick them up. There's the proposed plan back there.

There's also a copy of the presentation if you want to get a closer look at some of the slides. I know it's a little difficult to read the screen if you are towards the back.

So take a look at the slides. There's also a copy of the public notice that went out regarding the proposed plan being available for review. This ran in the New London Day back on June 14th.

So if you need those, go ahead and grab them. There's also a sign-in sheet back there to make sure we have a record who is attending the meeting.

Dick went through most of our agenda here. We've gone through our introductions. This presentation, we're going to review the regulatory process, describe operable unit 9, some of the details, characteristics of it and then also present our proposed plan for addressing the ground water and operable unit 9.

Once we wrap up the technical presentation, we'll open the floor for formal comments and try and provide all the responses that we can at this time.

If there's a comment raised we can't address, we'll get back to you in writing with additional information once we can get that information available. And then, we'll close out the meeting.

Through the regulatory process to summarize CERCLA, the Comprehensive Environmental Response Compensation and Liability Act, there's multiple steps in the process under CERCLA from preliminary assessment site inspections and studies to determine what to do with the contamination you would find formally documenting the remedies that you're going to select through a proposed plan and ROD, then going through a remedial design to figure out how to address and implement that remedy than actually doing the remedy, the remedial action, and then going through operations and maintenance if that's necessary for that particular site.

As we talked about tonight, we are here to present the proposed plan. Obviously, that's why it's highlighted in red.

So we are here to present the alternatives that we have decided are the best for the groundwater operable unit 9 and to get feedback from the public on it.

Slide: So this slide helps us to understand what the proposed plan is for. It facilitates the public involvement in the CERCLA process.

It presents the lead agency's -- who, in this case, is the Navy -- their preferred alternative to address the contamination present, all the alternatives that were evaluated, and the reasons for selecting preferred alternatives. And it's a requirement for public participation under CERCLA and the NCP.

The next step in the CERCLA process is to develop the record of decision, formalizing the selection process. It's a legal document that certifies that the remedy selection process was done in accordance with CERCLA.

It provides all the technical backup for the alternatives that were considered, all the engineering components, the remedial action objectives, the cleanup levels and so forth.

And it is a tool to explain to the public the problems the remedy seeks to address and the rationale for its selection.

So with that introduction, we are going to move in to operable unit 9, go through some general introduction and then get into each of the specific sites and the details of each of those sites.

So operable unit 9, it's New London, includes sites at these ten -- includes ground water at these ten sites. We have broken out 2-A and 2-B in this summary.

Ron, if we could go to figure one. Just click on that.

Probably best to look at this in your handouts. I'll give you some general directions. North is at the top. South is at the bottom.

Route 12 is running right here. Thames River is over here. There's basically two portions of the sub base, kind of the northern portion that we have some groundwater concerns at.

Site 2 is the Area A landfill which is up here, which has been addressed -- the soils have been addressed. Area A Wetland which is Site 2B is up here.

Site 20 which is the weapons center is right here. Site 14, over bank disposal area northeast, is right here. Site 7, the torpedo shops, is in this vicinity. And Site 3 area downstream is right here.

This is a east-to-west trending valley, and most of the groundwater migrates to the west obviously and discharges into the Thames River.

If we could head south then. Southern part of the facility, Crystal Lake Road, main gate right down here. We have four sites down in this area.

We have Site 15 which is the spent acid storage and disposal area right here. Site 18 was the solvent storage area building.

We have Site 9 which was OT-5 or waste oil tank 5. And then we also had Site 23 which was the tank farm where they previously had underground storage tanks in that area.

So if you just minimize that.

So for several of these sites, Site 3, 7, 14, 15, 18 and 20, the Navy felt we had sufficient information to go to a ROD, and we developed an interim ROD and signed that ROD back in December of 2004.

So for those sites, we've implemented remedies. And at that time, there was not enough information for Sites 2A, 2B, 9 or 23 to go forward in the ROD process.

So some additional data has been collected since 2004. There's been some additional evaluations, risk assessments done with that data.

And then tonight we are combining all that information or we have combined all that information into one proposed plan to document all the final remedies for all ten of these sites.

Next slide: So to get into the detailed description of the sites, we have Area A landfill Site 2A and Area A Wetland 2B.

As we saw in the previous slide, the sites are both located in the northeastern-north central portion of New London. The land fill is about 13 acres.

The wetland is approximately 26 acres. The landfill is relatively flat, bordered with some steep wooded hillsides to the south, wooded ravine to the west and area wetland to the north.

The major source of contamination in this area for the landfill was disposal of incinerated combustible waste, refuse, debris, so forth was put in the landfill.

At one time there were some storage pads on top of the landfill where some transformers and electric switches were stored. There's also some petroleum compounds were disposed up there, and there's also some spent acid solutions that were poured into some trenches in landfill.

In the wetland itself historically DDT was used as a pesticide to control mosquitoes in that area. In the late '50s the area -- wetland area was filled in with some dredge spoils that were pumped up from the Thames River. Dredge spoils average about 10 to 35 feet in that area.

This photo is a picture of Area A landfill looking south. The current surface is all paved and used for storage of equipment of materials for the Navy. You can see the rocky outcrop on the south side there.

Next slide: This is Site 2B Area A wetlands. It was a cold day. Everybody was doing our site inspections I think back then. But you can see the wetland area is predominantly covered by phragmites, grassy areas there to the north, looking north here.

Next slide: So the nature and extent

of contamination for 2-A and 2B, these sites were included in several investigations, Phase II RI, the base-wide groundwater OU RI.

We completed the RI, and the recommendations out of the RI were to continue monitoring the groundwater at these sites under a previously signed ROD.

There was a cap installed at Area A landfill back in '97, I believe it was. And as part of that ROD there was a groundwater monitoring component that was part of it, and so the groundwater at that site was being monitored.

To date there have been eight years of monitoring completed, and that information helped us further evaluate the issues at Sites 2A and 2B. The most recent ground, they are on biannual sampling effort up there now was in 2006.

If we can go to figure 2 there, Ron.

Overall, we haven't seen any significant issues with the groundwater coming out of the landfill. Most of our monitoring well networks are along this side of the landfill.

Groundwater flows in this direction. We have a series of wells along this northern boundary. We've been monitoring those as I said for eight years. There's also wells in the area downstream to capture flows that moves in this direction.

But overall we haven't seen any significant hits in these wells. The only hit that we saw was actually on a side gradient well which was a reference well we were using, and we saw some copper in there in 2006.

But that appears to be related to a site unrelated to our Area A wetland/Area A landfill.

So this information has told us that our cap is working properly, and we don't have significant migration from the landfill itself.

Next slide: We also updated our risk assessment using this most recent data. We went back using the data and some latest methodologies that are available. Those evaluations showed us that there were no unacceptable risk to current receptors.

The only possible current receptor would be a construction worker that would go in and excavate and expose the groundwater and come into contact with it.

But if somebody would hypothetically put a well in there and try to develop it for residential use, groundwater may present some unacceptable risk to those hypothetical receptors.

We also went back and looked at vapor intrusion issues, that is if there's any volatiles present in the groundwater that could migrate up through to the surface and any inhabited buildings or so forth would present any risks that evaluation showed that the volatiles that are there.

If there are any at low enough levels that they are not causing any risk to human health at this point.

At Site 2B there's some ecological risks associated with the site. Back -- the groundwater itself was evaluated, and surface water was evaluated.

And the groundwater is not expected to present any risks -- wait. Go back. Exposure of ecological receptors to groundwater or surface water affected by groundwater are not expected and, therefore, not evaluated.

Site 2A, groundwater at 2A discharges to the surface water in the area wetland. And the results of the Phase II ecological risk assessment indicated that there were some chemicals in surface water, sediment, and soil that could adversely impact ecological receptors.

We are currently still evaluating the sediments at Site 2B. There's an ongoing remedial investigation for that site.

We are going to have some ongoing discussions with the regulators on that tomorrow as a matter of fact, and there will be final decision on that in probably about a year. There will be a decision on how to address the risks associated with the sediments there.

So overall, as far as groundwater is concerned, there's a current monitoring program under OU-1.

There's institutional controls in place that prohibit use of the ground water, and at this point because we have these controls in place, the monitoring in place, there's no FS required. Feasibility study is what FS stands for.

Going to move on to Site 3, trying to cover and evaluate all these sites, and then we'll go through the alternatives we developed for them and show our recommended alternative at the end here.

Site 3 is area downstream water courses and the over bank disposal area. This site covers about 75 acres and contains mainly undeveloped wooded areas and recreational areas.

Historic major sources of contamination were past application of pesticides, abandoned disposal areas, and the Site 7 septic leach fields.

Site 7 is located just upgradient -- side gradient of Site 3. And there were some leach fields in there and historically some materials may have been exposed in the leach field and migrated down through Site 3.

There was a large remedial action in that site for the soils and sediments back in '99 and 2000. About 18,000 tons of material was removed from that site and disposed of off site.

Another smaller area that was found during this remedial action, the Site 3 new source area was remediated back in October of 2007. So just about eight, nine months ago. That material was excavated and disposed of off site as well.

This is -- this picture is of Site 3. This is OBDA pond and site or stream one. Area A landfill would be just upgradient of this. And this heads south towards the golf course. So give you a some landmarks as to where we are at.

As far as nature and extent of contamination, this site has also gone through several different phases of investigation. The main groundwater contaminants of concern were chlorinated solvents.

Trichloroethylene was the primary contaminant concern, and most of these TCE was detected primarily along stream five which is along the northern board of Site 3 and just downgradient of the leach fields that I talked about at Site 7.

So we feel that that was the primary source of the groundwater contamination we had seen there.

We can go to figure 3. Again, hopefully you can see these in the back of your packet. The picture or the figures are at the back of your packets. But this is historical information from 2000 -- the base-wide groundwater RI.

This is Triton Road, Shark Boulevard. This is Site 7, the torpedo shops. This area is area downstream.

Primarily we've seen contamination right along this area. This was the leach field. There were two leach fields here, a south one and a north one.

But you can see the concentrations that have been detected there. TCE is the primary contaminant. We've had some degradation compound like vinyl chloride and cis-1, -2 dichloroethene as well in the well.

If we can go to slide four or figure four. Because we wrote an interim ROD back in 2004 and selected a remedy, we've been implementing that remedy over the past two years. And in Site 3 there was a remedy selected.

So these results are the most recent of the groundwater monitoring program that we've had at the site.

There were three wells where we've continued to see some contaminant levels above our remedial goals that we've selected, 3MW16D, 2DMW29S and 2DMW16D.

And the levels that we're seeing are marginally above our medial goals. In general we haven't seen significant groundwater contamination. It's generally been just marginally above our goals that we've selected.

Also historically, we had put in a few temporary wells near Site 3 new source area when we were investigating that. We had some hits of PAHs.

But after we went back, reevaluated the data and as is typical with temporary wells, we found a lot of suspended solids.

We had high turbidity in those wells, and we picked up maybe some material from the asphalt or maybe some material from other places.

And we found that those detections were not truly indicative of something in the groundwater itself as much as the suspended solids that were in there.

Next slide: As far as the human

health risk assessment for Site 3 goes, there's currently no unacceptable risks to current receptors that would be construction workers from exposure to the groundwater.

However, if hypothetically in the future, a residence was built on this site and the groundwater was used as a drinking water source, there would be a potential for human health. The primary contaminants of concerns are TCE, trichloroethylene and vinyl chloride.

As far as ecological risks, though, there's no significant risk anticipated from migration of the groundwater to surface water.

Next slide: Recently here in 2008 we went back and revisited vapor intrusion. There's been some new guidance, new information out. Went through that evaluation.

And again, we saw no unacceptable risks to current industrial land use which is what the Navy is using it for at this point.

But there is a concern at one well, 2DMW29S. If the land use would be changed to residential, there may be some -- there are some restrictions that would be required to make sure that no residence would be built within a hundred feet of that well or in areas where contamination would be at similar concentrations.

So because of those risks, because of those issues at Site 3, this site went through a feasibility study.

Before you start your feasibility study, you look at your risks and you determine what type of remedial action objectives you're going to have so you can develop your alternatives to meet these remedial action objectives.

And the three objectives that were developed and determined to be appropriate include a protection of current receptors from incidental exposure to groundwater with petroleum or chlorinated solvents at concentrations above PRGs, also protect any future potential receptors from regular ingestion or exposure to groundwater via vapor intrusion, also protect any aquatic ecological receptors through migration of any petroleum contaminated groundwater into surface water.

After defining these, then we developed remedial alternatives to address the contaminant levels. Considering the dilute disperse contamination that we saw there, we just developed two alternatives, the first being a no-action alternative which was required under CERCLA, which we just consider ongoing five year reviews of the site.

And we also looked at an institutional controls and monitoring alternative which is a limited action scenario where we place restrictions, we formally identify the location and magnitude of the contamination and put restrictions on extraction of the groundwater.

We also put controls on vapor intrusion based on land use. We also monitor migration and degradation until contaminants reduced to the remedial goals, and we continue to conduct five-year reviews.

So those were two alternatives to Site 3.

Moving on to Site 7 which is the torpedo shops also located in that northern area. The site includes four buildings, and it's on the northern side of Triton Road. It's used for maintenance for the torpedoes.

Solvents and petroleum products were used at the site during maintenance activities, some of which may have been disposed of in on-site septic systems until 1983.

There's also some underground storage tanks that were used to store petroleum products for use primarily for heating purposes, I believe, inside the facility and may have been some waste liquids and so forth stored there and possibly discharged.

There was remedial action on the

soils and septic system back in 2006. Some contaminated soils on the western side of building 325 and also the southern side of building 325 that were excavated, removed and disposed of off site.

This is a picture of building 325. One excavation as we mentioned for soils was done on this side of the building. The other was on the southern side of the building.

Next slide: Site 7 also investigated during several remedial investigations, several phases. Primary contaminants also included solvents, some benzene, chlorobenzene, trichloroethylene detected here at building 325.

We can go and take a quick look at those -- look at five first. I kind of have them in order there.

First slide shows -- or first figure, figure five, shows some historic contamination detected in these wells.

The data set provided includes

detections and non-detections to understand the distribution of and contamination. If you see a "U" after the result, that means detect and non-detect. That's a detection limit that the laboratory was able to see down to.

A "J" is actually a detection, just shows that there's a little bit of uncertainty with that data, depending on action limits, detection limits at the lab.

Primarily we saw contamination right near the septic system, this cross-hatched area identified where we saw the contamination historically.

Go to I think it's slide three or figure three.

This is back to figure three where we showed all Site 3 and Site 7 contaminants of concern. There were several wells that we saw in 2000 that had some detections of trichloroethylene driving some of the risks there.

And then, after the 2004 ROD, we

implemented a groundwater monitoring program similar to Site 3.

You can go to figure four.

As part of that program, this is Site 7, we actually have not detected any contaminants above remedial goals in this well at this point.

So within the past eight years, we -- concentrations have decreased below our remedial goals and are no longer really a concern at this site.

So with that said, human health risk assessment was recently revisited. No unacceptable risks to current receptors. There's still this potential risk to hypothetical future residents.

This was primarily developed, defined with some of the historic data. As we said a lot of the risks are reducing -- concentrations appear to be reducing.

They are really -- risks are decreasing as we speak. Ecological risk assessments, no real significant risks with ecological receptors. 2008 vapor intrusion evaluation indicated no further action is required for vapor intrusion.

We still went through the process of RAOs, alternative development for Site 7 as we did when we developed the 2004 ROD. Again, the RAOs were similar to protect current receptors, future receptors and the aquatic ecological receptors.

For this site we had actually looked at three alternatives, a no-action and institutional controls and monitoring.

And also because originally when we were looking at this site, there was a very defined, small contaminated source area right near building 325, we looked at more aggressive approach and then pump and treat or extraction on off-site discharge so that we may be able to capture that.

Because we have new data and new information, this alternative is probably too aggressive with the data we've seen since then.

Pump and treat, again as far as costs go, is significantly higher than institutional controls and monitoring which is more appropriate for the types of contaminants and concentrations that we've seen out there.

So move on to the next site, Site 9 --

If there are any questions that you'd like to ask during the presentation, just let me know. Formally we'll try to document those in the next public hearing part of this presentation.

Site 9 is waste oil tank, waste oil tank 5 -- sorry. It was a 750,000-gallon underground concrete storage tank. The soil at the site was investigated and addressed under corrective action under the state's RCRA program.

Tank was used to store fuel oil, bilge water and other waste oil solutions. The tank's use was discontinued back in 1993. All of the contents were removed.

There were some PCBs or polychlorinated biphenyls detected in the residual sludge that was in there. That was subsequently removed and disposed of properly, and the tank was actually closed in place then.

This tank is located within the boundaries of Site 23, the tank farm and as a whole. Because it's all within that one site, we were addressing the groundwater within the Site 23 efforts.

Interesting picture, just a blank field that's where the tank was. Nothing very obvious there, but the tank was in this area.

Site 14, over bank disposal area northeast located up in the same general vicinity as sites 3 and 7. Miscellaneous wastes were dumped there over the edge of ravine.

The material covered about 80 feet in diameter, really small area, disposal area. Back in 2001 the entire waste material was excavated and disposed of off site.

It was about 270 tons of material that were excavated and taken off site for disposal.

This is a picture of the site after it was restored.

Next slide: As far as nature and extent of contamination, this site was investigated during several phases. The only thing detected in the ground water adjacent to this site were naturally occurring metals.

Human health risk assessment did not indicate any unacceptable risks due to exposure from groundwater. We didn't detect any volatiles, so there were no vapor intrusion issues. Ecological risks had no issues as well.

And, therefore, we did not proceed to an FS or develop alternatives for this site.

Spent acid storage and disposal area, Site 15, is located in the southern part of sub base New London. It's located between buildings 409 and 410. Historically there was a rubber-lined underground storage tank at this site that was used to store waste battery acid.

Batteries were a big part of submarine use historically. Since the Navy has gone nuclear, batteries aren't used like they were in the past.

But when those batteries ran their life cycle or the acid in the batteries ran their life cycle, it was a placed -- temporarily stored that waste acid.

There was a removal action completed back in '95 in which 318 tons of lead contaminated soil were removed. And the tank itself was removed, and this material was disposed of off site.

This is a picture of the site. You can see the rather triangular-shape cut in the asphalt there. That was where the tank was and the removal action that was done there.

Nature and extent of contamination, overall from the various investigations that were done, some TCE and metals were detected at elevated concentrations in this area back in 2000 during the base-wide groundwater RI.

We -- these detections were somewhat anomalous when we first saw them because we had some historic data that didn't show us these same issues.

Once we saw these contaminants of concern, we conducted a data gap investigation, went back, resampled these wells again. And it appears that these results from the BGOURI base-wide groundwater RI were anomalies.

Several factors that were considered may have contributed to these anomalies. The wells hadn't been sampled in a long time. They weren't redeveloped.

Maybe some particulates, other materials settled in these wells. Some different sampling techniques were employed at that time, and there was also some interferences.

So pre-BGOURI, post-BGOURI showed one

thing. These other set of results showed another. We based our determination off of the whole set of data that was available to us.

So looking at that whole data set, we did not determine any unacceptable risk to human health from exposure to the groundwater.

There's really no exposure pathway to ecological receptors at this site where the groundwater discharge and impact them.

We also reevaluated vapor intrusion which showed no significant issues. And again, without any true issues, we did not proceed to an FS to develop alternatives.

Site 18, solvent storage area, building 33, that's located in the southern portion of New London.

You can close that out.

Historically, that building was used for storage of gas cylinders and some drums and solvents. No expected or documented spills, leaks, whatever at the site.

Go to the next slide. This a picture of the building as it was several years ago.

Next slide: We did an investigation at that site in the -- in around 2000, and we found no significant groundwater contamination around the perimeter of the building.

We looked upgradient and downgradient of the building. We really didn't detect any significant levels of contamination.

We looked at what we did detect -- in the human health risk assessment identified, no unacceptable risks during that evaluation, and we detected no volatiles in that area.

So there were no vapor intrusion issues. Also, no real exposure pathways for ecological receptors and no reason then to proceed to a feasibility study.

Going down to the last two sites here, Site 20, area weapons center, that's back up in the northern portion of the facility up by Site 3 and Site 2, Site 7, in that same area.

Historically -- or weapons center is used for weapons storage. There's bunkers there. There's also a small building, building 524.

There's some small quantities of chemicals, solvents and wastes that are generated at that site, maybe some fuels -- well, there's fuels and also explosives that are stored in the bunkers up there.

Soils were addressed through remedial action back in 2001. 200 cubic yards of PAHs and metals, contaminated soils were removed from the site, taken off site and disposed of, as far as groundwater is concerned.

Here's a picture of the facility. Bunker storages or storage bunkers on your right. There's some access roads on your left.

Groundwater is investigated during four different phases. There was some low-level detections of volatiles and semi-volatile organic compounds, TCE and PAHs, detected in the groundwater. We also saw some naturally occurring metals.

Those contaminants were evaluated through our human health risk assessment. Through the various investigations, the most recent data showed no significant risks to human health.

There was also some changes to methodologies, sample analysis, sample collection that contributed to some changes over the years of different evaluations that were done at the site.

We took a fresh look in 2008 at vapor intrusion indicated there were no significant risks to human health from this site.

As far as ecological concerns, there were no unacceptable risks determined from this site from groundwater migration to surface water. And again, because no real risks associated with exposure to groundwater at the site, we didn't proceed to a feasibility study.

Last site, Site 23, tank farm, located in the southern portion of New London, there were 10, 11 USTs at Site 23 historically. Those have all been closed out.

There were some evidences of releases of petroleum products from those tanks and piping. The soils associated with contaminated soils were addressed through several small removal actions that were done under the state's UST program.

And each of those tanks that were closed in place, obviously the product was removed from them, the tops were demolished and then they were backfilled. The tanks were filled with stone, crushed stone, and the area was backfilled.

But because of that area historically being a lake, Crystal Lake, there's groundwater issue in that area as far as groundwater level is elevated during rainy parts of the year. There's some buildings that have had some flooding issues on the sub base.

So the ring drains that were in that area to depress the water table around USTs were left in place and continued to help collect groundwater and discharge that so that we can depress the water table in that area. So those ring drains are still in place, and they are collecting groundwater.

So we have -- if you move to the next slide, this just gives you a picture of the tank farm area. At the surface it's all the ball fields that you can see out at sub base and all the former tanks are underneath these ball fields.

So those drains were -- portions of the drains were rehabbed back in 2000 when the storm sewer system went under some renovations.

The deep groundwater system now connects downstream with the shallow surface water that's collected in the new system that was installed back in

2000, and then all that water, both groundwater and surface water, eventually discharge into the Thames River down in Goss Cove.

If we look at figure six, you can see the blue outline or the former tanks and the drains.

The ring drains are around there, and the discharge pipes that go out and tie in with this deep dewatering system as well in the red that you can see.

These were also historically storm drains. But when the new system was installed, they were basically abandoned as storm-water conveyance -- for storm-water conveyance and now just collect groundwater to help dewater the system. So these are actually all perforated pipes that allow collection of groundwater.

The greenish-yellowish system is the most recent system that was installed, and then the light blue system is the existing system that's out there.

But for this -- for this site, because these areas were continuing to collect groundwater and continuing to discharge that groundwater to the Thames River, there was a metering pit put in here so that we could sample that, make sure that contaminated groundwater wasn't being discharged and wasn't posing a potential threat to human health or the environment.

So we've been studying that for the past year.

Go to the next slide.

Well, overall the groundwater was investigated back in 2000 in the BGOURI. We didn't see any real significant contamination back then.

We opted to postpone proceeding to the FS until we could evaluate the groundwater being collected by this drain system, under water drain system.

We did one year's worth of data collection out there from 2007 to 2008. We only saw some minor exceedances, really I think from arsenic and a couple PAHs.

But we also had some suspended solid issues there especially from the arsenic. We looked at total undissolved results there, and the arsenic in the dissolved was much lower than the criteria in the concentration that we saw in the total sample that was unfiltered.

The PAHs, again, we had a stray hit during one of the three rounds or one of the four rounds, and we did not have similar results in our sample in duplicate. So again there's some likelihood of suspended solids contributing to that as well.

Next slide: We took that most recent data. We evaluated the risks back in the base-wide groundwater OURI and found that those risks were acceptable at that time.

We took our new data, also evaluated that in 2008 and showed that there were no unacceptable risks to the construction workers under the current industrial land use scenario.

Conservatively, we estimated some potential risks to hypothetical residents in that area, but our data really shows minimal impacts to the groundwater.

It's more of a cautionary that these risks are being identified. We also looked at vapor intrusion exposure pathway and did not see any potential issues associated with that.

Because of those potential hypothetical risks to future receptors, we did go through evaluation of alternatives, developed two remedial action objectives to protect those future receptors and also protect the ecological receptors that may come in contact when the groundwater discharges the surface water.

Looked at two alternatives here, no action and institutional controls and monitoring.

As far as alternative two is concerned, we would locate the areas contaminated with groundwater contamination and restrict extraction and use of that groundwater and then conduct five-year reviews as well.

So that concludes a summary of all the background information, the nature and extent of contamination, the alternatives we evaluated and basically a summary of all the information for those sites.

Now, as far as our proposed remedy, if you recall, we had -- we have remedies proposed for Site 3, Site 7 and Site 23. Those were the sites where we had risks.

As far as sites 3 and 7, because of their proximity, the similar contaminants of concern at those sites, we're lumping our proposed remedies together.

Alternatives GW1-2, GW2-2 which were institutional controls and monitoring, as part of those remedies as discussed previously, we would continue our institutional controls that were identified as part of the interim ROD or implemented as part of the interim ROD.

And those controls locate or identify the location and magnitude of the groundwater contamination. They restrict extraction and use of groundwater.

And for Site 3 because we had a vapor, a potential vapor intrusion issue, that will also identify that as a potential concern.

If you want to go to figure seven, this figure identifies areas at the sub base that have land use controls. And sites 3 and 7 here are shown in yellow.

They have land use controls on groundwater use, and they'll continue to be implemented as long as groundwater contaminants exceed remedial goals.

You can go back to that slide.

Again, as we said, we'll continue to monitor until those concentrations decrease. We'll continue to do five-year reviews, and the total present worth cost of this alternative as estimated previously was $623,000.

The contaminants of concern for sites

3 and 7 and the remedial goals selected are summarized in this slide. We have six contaminants, all solvents for the most part, dichlorobenzene, benzene, chlorobenzene, hexachlorobenzene, trichloroethene and vinyl chloride.

Most of these levels that are identified are based on Connecticut RSRs. Mostly drinking water exposure concerns, the only one that's not is the vinyl chloride. That's based on a vapor intrusion issue concern.

For sites 9 and 23, the proposed remedy is institutional alternative GW3-2 where we'll implement controls to identify or to restrict extraction and use of the groundwater.

Figure seven is that same land use control figure we just saw.

As of right now, we are preparing to put into action the land use controls that will be a follow-on to the record of decision that's signed for this site. So we'll implement those controls at Site 9 and 23 in the near future.

And we'll conduct five-year reviews, and the total present worth cost is estimated to be about $120,000 for that remedy.

The remaining sites, sites 2A and 2B, because they were -- the groundwater in essence was addressed under OU1, we'll continue to implement those institutional controls and monitoring that were implemented under OU1 for those sites, continue to monitor any potential migration contaminant issues associated with the landfill.

For the remaining sites 14, 15, 18 and 20, the proposed remedy is no further action. Basically the data available indicates that groundwater doesn't pose any significant risks to human health or the environment.

So those are the proposed remedies. The public comment period, as we talked about at the beginning of the presentation, began back on June 14th, 2008. It will wrap up on July 14th.

We are having our public meeting this evening. Once we finalize the public comment period, we'll prepare our responsiveness summary, a formal document that summarizes all the comments received and official responses to those comments.

That document will get incorporated into the final record of decision, and we hope to have that final record of decision in August or as late as September of this year.

As far as points of contact, if you feel you want to provide some additional comments after this evening or don't want to mail in comments, you can contact individuals up here on the screen from the Navy, Mr. Ron Pinkoski who is the remedial project manager with Midlant (phonetic) down in Norfolk, Mr. Richard Conant here at sub base and the regulators, Ms. Kymberlee Keckler with EPA and Mr. Mark Lewis from the DEP.

So that concludes my presentation. If there's any official comments, we'll move into the hearing portion of the meeting. If there's any unofficial, we can take those, too.

Just off the record at this point.

Anybody have any comments?

MARK OEFINGER: Mark Oefinger from the Town of Groton, probably unofficial, just, maybe, for future consideration.

I got notice of this on Tuesday. I hadn't seen the ad in the paper, and I was just -- I got it from Harry Watson who is currently the town manager.

But I think he got it because he was a member of the committee that met for years and years and years. And I would just suggest in the future -- and I thought it was the practice.

But at least, in the future, that when we have these types of reports, I think this -- you guys have done great work as far as I can tell. I'm very impressed at the thoroughness.

But I would suggest that in the future when we are going to kind of roll out the final recommended plan, that communities get notified formally, either the mayor who was notified but I think inadvertently because you didn't know he was a mayor.

He was a member of the committee because I don't -- the host communities for the Town of Groton or Ledyard. I don't know anybody from Ledyard is here, but I doubt the Ledyard town council is aware of this meeting.

I know I would have at least one counselor who would be very interested in being here. She couldn't be here because she's out of town. And it's just a heads-up for the future. I know you have -- receive comments to the 14th.

But we usually always get notified about everything at the sub base. The sub base does an excellent job at keeping the host community informed.

So just for future consideration and formal comment I want to pass on to you.

COREY RICH: Yeah. Maybe, Dick, you

are best to speak to this. But I know the Navy tries to inform the public as much as they can.

As far as the RAB distribution list, I think they have thirty-some --

RICHARD CONANT: -- thirty-five.

Actually, Mark has got it in front of them there. I think we can probably do better as far as getting something directly to the higher ups at Ledyard and Groton.

Of course, we do have the repositories out there, the Bill Library and Town of Groton Library.

And all documents that will be finalized are available over there, and I'm fairly religious about getting those over --

MARK OEFINGER: I see that they are on the list and in the legal notice.

RICHARD CONANT: We certainly -- we are in an end game with this program. I think certainly aside from the legal that was published on this, I can endeavor to get -- maybe beef up that list a little bit so it gets out to certainly you. Mr. Watson has been involved for many, many years.

MARK OEFINGER: Yes, he has.

RICHARD CONANT: We haven't had a lot of contact with Town of Ledyard, and maybe we can establish that.

MARK OEFINGER: I do know I do have at least one counselor who will probably make more of an issue that they weren't aware of a hearing than the comments and the recommendations and the protocols that you've identified. So it's just --

RICHARD CONANT: Well, certainly the public comment period is open for another couple weeks now.

So we'll entertain a call, e-mail to either point of contact, written response --

MARK OEFINGER: I will follow up with this one particular counselor.

We did scan this in and e-mail it out to the entire council.

RICHARD CONANT: What would be the

most -- I mean, the Town of Groton is a big place -- the most appropriate POC?

MARK OEFINGER: Town manager's office.

RICHARD CONANT: Okay, most definitely.

MARK OEFINGER: At least, if the town manager doesn't notify people, they know who to hang.

RICHARD CONANT: For many, many years we've been sending something out to Deb Jones --

MARK OEFINGER: Right.

RICHARD CONANT: -- our point of contact. But maybe this should be bigger than that.

When we were dealing with resources, she seemed to be the planning phase to this whole thing.

MARK OEFINGER: Yup. Yup.

RICHARD CONANT: I actually haven't had contact with her for a number of years on this.

MARK OEFINGER: I tried contacting

her today to see if she was coming, and I didn't have any luck.

She may be off this week. It isn't a criticism. It's just in the future.

RICHARD CONANT: No. We have that reported and fair comment.

And I think we can do a little better as far as trying to hit up high and if it can trickle down as far as what notifications you would like to make to your people.

MARK OEFINGER: Great. Appreciate it.

RICHARD CONANT: Certainly, we try to get some attendance at these meetings, and it's like pulling teeth sometimes.

So it would be great, anything we can do to -- especially as we get into lower base which is going to be an exciting site.

Why don't we segue right into the public hearing here.

Thank you very much, Corey. Good presentation, very complex. We were a little worried about the number of slides here.

But groundwater covers a lot of sites out there. It's a complex situation. So we had to come think it through, and I thank everyone for bearing with us.

But certainly now this is the formal public hearing. If you have comments, if you have questions to direct anyone here, to direct to the Navy or to the EPA and the State that are represented here, please, you know, I would entertain anything at this time.

And certainly in the back of the proposed plan here points of contact Ron and myself. If you want to give us a call, send us an e-mail, smoke signal, whatever you care to do, we'd be glad to take your comments right up to the public when we close the public period in about two weeks.

COREY RICH: Dick, maybe also bring to their attention that they can provide comments, written comments.

You just fold it over. Your address

is on there. You can fold it together and mail it in.

RICHARD CONANT: If you would like to send it in snail mail to me, that's fine. It's right on that sheet there.

So any questions, comments.

Mark, again.

MARK OEFINGER: Again, Mark Oefinger from Groton. And this is really a question I'm curious: When we were talking about Site 23 which is the old tank farm, and if I understood -- I remember when that project was done quite a few years ago, but the sides and the bottom of the tanks were left in place and filled with stone?

COREY RICH: Correct.

RICHARD CONANT: That's correct.

MARK OEFINGER: And the perimeter drains we're using because there's high ground water there, would it have been better to actually remove -- I'm assuming the perimeter drains are needed because there's still contamination in the cement or in the tanks or whatever is there or --

RICHARD CONANT: The ring drains are primarily there because we have to continue dewater out there.

We'd be concerned if ground water comes up, not only would we flood out what used to be Crystal Lake out there 50, 60 years ago, but also we might float some of the carcasses of the tanks.

Now, the tanks, I got a look at them back in '94. We were cleaning them out. They are so big you could play tennis inside of it.

MARK OEFINGER: I remember.

RICHARD CONANT: And they were reinforced concrete. They don't build them like that anymore.

We actually had a huge amount of trouble even stowing in the top of them. We didn't think we could do that.

MARK OEFINGER: We are monitoring the groundwater, I suspect, because there's potential for pollution, or did we get all pollution at the time?

RICHARD CONANT: Exactly.

MARK OEFINGER: Okay.

RICHARD CONANT: There is some remnant oil contamination in place and primarily these tanks are used to store bunker fuel and No. 2 heating oil.

The one exception to that was the one we converted over to storing waste oils there.

COREY RICH: Site 9.

RICHARD CONANT: Which is Site 9 that Corey went over.

Yes, there is still some oil contamination out there.

We are really pursuing natural attenuation that was a breakdown over time, but the concern is that there is a pathway through the deep drain system --

MARK OEFINGER: Okay.

RICHARD CONANT: -- and the storm water system to the river, and that's why we are monitoring.

MARK OEFINGER: Thanks.

RICHARD CONANT: Anything else?

FELIX PROKOPF: Felix Prokopf, Ledge Light Health District.

The Ledge Light Health District covers five towns, Ledyard, Town of Groton -- City of Groton, Waterford, New London, and East Lyme. So I deal with a lot of board members and things like that.

Maybe something like what Mark is saying, if I could have or we could have -- I know, there's a lot of detail in this -- maybe like a two- or three-page statement of what you are doing --

RICHARD CONANT: Okay.

FELIX PROKOPF: -- to contact them. I saw something like that. I said, Jeez, I should have made a copy of it.

And I was going to call you up on it where I can have two or three pages. Because we deal with a lot of board -- people change every two or three years.

There's new elections like health

district board. It would be nice if I could give them something not so detailed.

Something -- a quick overview of what's going on and, then, where they can get the information like at the library. I think I saw Andy's number on.

RICHARD CONANT: So you are looking for something more general, a snapshot of the entire program?

FELIX PROKOPF: A new member on board, this is what is going on, that maybe something like that. I have two or three cars that I travel around with.

Maybe something like that, Mark, that would be handy. Because you, like -- you deal with members all the time. So here's what going on at the base.

They may not know -- that would help me so I can give them so I don't have to explain what's going on.

RICHARD CONANT: I think we have --

FELIX PROKOPF: Maybe this is -- I'll

take a look at it.

RICHARD CONANT: I can think of a number of things we might have.

FELIX PROKOPF: Not so much detail, just here's what we're doing. I don't know if I'm explaining it right.

Something that explains what you are doing here, what's going on in proof and then contact numbers.

RICHARD CONANT: Certainly. Certainly. I certainly have something like that, and I can provide it.

Kimberly?

KYMBERLEE KECKLER: Yeah.

I wanted to point out that EPA's website for the base is about two pages, and it summarizes the progress at all of the sites.

RICHARD CONANT: Yeah.

FELIX PROKOPF: Again, that information would be put on this little simple handout, if I get called from another town, I can quickly hand them something on file.

RICHARD CONANT: We can certainly cobble something together I think would meet those needs there that as far as a snapshot of where we are at this time with the program and where we're going and certainly provide EPA's website as well which is the official website for this federal facility.

FELIX PROKOPF: If I could say something to Mark: These guys have been doing a terrific job.

I have been going to the every meeting for the last -- I don't know how many years. I don't even know how old I am.

They tried and Sue Orrell, she used to call. She used to call all these officials, and nobody ever -- very few people showed up.

So you did have a very good system.

I don't want to say it's lax but even the last -- how many years have we been coming?

RICHARD CONANT: Early '90s.

FELIX PROKOPF: Am I old?

But they had a call system. Sue had a calling list and things like that. So they have been doing it in the past.

RICHARD CONANT: I think we had a lot more interest in the past. And as we've gotten into various programs, the interest has faded a bit.

And now maybe as we get to the end of this, we need to make an attempt to say, Hey, we are coming to the end of this, and it's time to maybe close things out.

And if you have comments or concerns or want to catch up, now is the time to do it.

FELIX PROKOPF: Only one free dinner, 10 or 12 years, cheese and Ritz crackers or something.

RICHARD CONANT: I'm sorry. We are protective of your tax dollars.

Thank you, Felix.

FELIX PROKOPF: Yeah.

RICHARD CONANT: Any other questions? comments?

Hearing none, we'll close the public hearing right now.

Certainly comments can be submitted via the means that we outlined.

Thank you all.

COREY RICH: Thanks.

(THEREUPON, THE DEPOSITION WAS CONCLUDED AT 7:43 P.M.)

CERTIFICATE

I hereby certify that I am a Notary Public, in and for the State of Connecticut, duly commissioned and qualified to administer oaths.

I further certify that said hearing was taken by me stenographically reduced to typewriting under my direction, and the foregoing is a true and accurate transcript of the hearing.

I further certify that I am neither of counsel nor attorney to any of the parties to said matter, nor am I an employee of any party to said matter, nor of any counsel in said matter, nor am I interested in the outcome of said cause.

Witness my hand and seal as Notary Public this 17th day of July, 2008.

Clifford Edwards

Notary Public

My commission expires: 9/30/2011

U.S. NAVY

SUBMARINE BASE NEW LONDON

PROPOSED PLAN FOR BASEWIDE GROUNDWATER
OPERABLE UNIT 9
PUBLIC MEETING AND HEARING
June 26, 2008

Attendee Roster

	NAME	ORGANIZATION	PHONE # / ~~FAX #~~	E-MAIL
1.	Noah Levine	RAB	860-442-5115	nlevine01@SNET.NET
2.	Linda Levine	Public	"	"
3.	Corey Rich	TtNUS	(412)921-8984	corey.rich@tetratech.co
4.	Richard Conant	Sub-se Env. Div	860-694-5649	richard.conant@navy.mil
5.	RON PINKOSKI	US NAVY	757-444-0785	ronald.pinkoski@navy.mil
6.	Kymberlee Keckler	USEPA	6179181385	keckler.kymberlee@epa.g
7.	Val Jurka	NAVFAC	757-322-8319	val.jurka@navy.mil
8.	Cliff Edwards	Court Reporter	860 604.1175	cliffedwards@comcast.n
9.	Mark Lewis	CTDEP	860-424-3768	mark.lewis@ct.gov
10.	CHRIS ZENDAN	USN/SUBASE	860-694-5980	CHRIS.ZENDAN@NAVY.MIL
11.	Larry Gibson	RAB	860-464-8281	lhgib@aol.com
12.	Felix Prokop	LL Health Dis	448-4882 Ex 329	
13.	Harry Watson	Mayor Town of Groton	7054551	hwatson5866@tvcconnect.net
14.	MARK R. OEFINGER	GROTON TOWN MANAGER	441-6630	moefinger@town.groton.ct.us
15.	Andrew Stackpole	NAVFAC PW Env. Div Director	860-694-3976	andrew.stackpole@navy.mil
16.				
17.				
18.				
19.				
20.				

APPENDIX E

HUMAN HEALTH RISK ASSESSMENT
2008 MEMORANDA

E.1 HUMAN HEALTH RISKS ASSOCIATED WITH SITE 2 GROUNDWATER

E.2 HUMAN HEALTH RISK ASSOCIATED WITH SITE 23 GROUNDWATER

E.3 VAPOR INTRUSION EVALUATION FOR OU9

E.1 HUMAN HEALTH RISKS ASSOCIATED WITH SITE 2 GROUNDWATER

From: Bob Jupin, Tetra Tech Risk Assessment Specialist
To: Corey Rich, Tetra Tech Project Manager
Date: May 19, 2008

Regarding: Human Health Risks Associated with Site 2 Groundwater

Historical and current information pertaining to Site 2 groundwater were reviewed to determine if Site 2 groundwater poses a threat to human health and the environment. Historical information reviewed as part of this evaluation consisted of the Phase II Remedial Investigation (BRE, 1997) and the Basewide Groundwater Operable Unit Remedial Investigation Report (BGOURI) (Tetra Tech, 2002). Current data reviewed as part of this evaluation consisted of the data included in the Year 7 Annual Groundwater Monitoring Report for Area A Landfill (ECC, 2007). Groundwater data presented in the Year 3 Annual Groundwater Monitoring Report for Area A Landfill (Tetra Tech, 2003) was used to evaluate the potential for vapor intrusion at Site 2. This was the last year that VOCs were analyzed for in groundwater samples collected at Site 2. VOCs were eliminated as a concern at Site 2 after eleven rounds of groundwater monitoring.

There have been changes in United States Environmental Protection Agency (USEPA) and Connecticut Department of Environmental Protection (CTDEP) guidance since the BGOURI HHRA was prepared. The major changes in guidance include:

- USEPA Region 9 Preliminary Remedial Goals (2004)
- CTDEP Remediation Standard Regulations (RSRs) Volatilization Criteria (2003)
- Draft Guidance for Evaluating the Vapor Intrusion into Indoor Air (USEPA, 2002).
- Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final Guidance (USEPA, 2004).
- Guidelines for Carcinogen Risk Assessment (USEPA, 2005a).
- Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens (USEPA, 2005b).

The revised guidance was used in this evaluation.

Site Description

Figure 1-1 shows the general location of the Naval Submarine Base and Figure 1-2 shows the location of Site 2. Site 2 includes the Area A Landfill (Site 2A) and Area A Wetland (Site 2B). Area A Landfill opened around 1957. Incinerated combustible wastes were disposed at the Area A Landfill until 1963, followed by refuse and debris disposal until 1973, when landfilling operations ceased. The thickness of the landfill materials is estimated to range from 10 to 20 feet. After closure, a concrete pad was constructed on a portion of the landfill. In the early 1980s, transformers and electrical switches stored on the pad were reported to be leaking. Spent sulfuric acid solution from batteries was poured into trenches dug into Area A Landfill for disposal and subsequently covered with soil. Petroleum compounds had been poured from containers at the landfill and had flowed into the Area A Wetland.

The Area A Wetland is located north of the Area A Landfill. In the late 1950s, dredge spoils from the Thames River were pumped to this area and contained within an earthen dike that extends from the Area A Landfill to the southern side of the Area A Weapons Center. The thickness of dredge spoils ranges from 35 feet to 10 feet. A small pond is located at the southern portion of the wetland, within which 1 to 3 feet of standing water is present during all seasons. Phragmites is the predominant type of vegetation. It was reported that formulated (water-soluble) 1,1,1-trichloro-2,2-bis(4-chlorphenyl)ethane (DDT) was used in the 1960s prior to the 1972 ban on DDT.

A two-phase Remedial Investigation (RI) was conducted for the Area A Landfill and Wetland from 1990 to 1995 and a Focused FS (FFS) was conducted for the Area A Landfill in 1995. An RA, which involved the construction of a low-permeability cover system over the landfill area, was performed in 1997. Operations and maintenance (O&M) of the landfill cover system and groundwater monitoring at the Area A Landfill and Wetland have been performed in accordance with the O&M Manual. Land use controls have been implemented at the landfill to meet the requirements in the ROD. The status of the Area A Landfill is considered RIP. A majority of the Area A Landfill is paved and is currently used for storage of equipment and vehicles.

Current and expected future site usage is industrial/commercial. Groundwater at Site 2 is classified GB. Groundwater at Site 2 is not used as a potable water source. Currently there are no direct contact exposures to groundwater. Potential receptors evaluated in the HHRA for Site 2A included construction workers and hypothetical future residents. Potential receptors evaluated in the HHRA for Site 2B included construction workers.

Phase II RI Report

Groundwater at Site 2B was evaluated in the Phase II RI (BRE, 1997). As part of the evaluation, concentrations of chemicals in groundwater were compared to USEPA and CTDEP screening criteria for direct contact (USEPA Region IX Preliminary Remedial Goals, USEPA Maximum Contaminant Levels, and CTDEP Maximum Contaminant Levels, and CTDEP RSRs). A copy of the comparisons is included in Attachment A.1. Maximum concentrations of bis(2-ethylhexyl)phthalate, antimony, arsenic, barium, beryllium, boron, cadmium, lead, manganese, nickel, thallium, and vanadium exceeded the direct contact criteria. Construction workers were identified as the only plausible receptor for exposures to groundwater under current and expected future site use. The cancer risk of 4 x 10^{-7} was less than USEPA's and CTDEP's acceptable levels. The hazard index of 2.2 exceeded the USEPA and CTDEP acceptable level of 1. Manganese was the major contributor to the hazard index. The HHRA assumed that construction workers were exposed to groundwater 8 hours a day for 120 days a year or the entire length of the construction project. This is a very conservative assumption since it is unlikely that a construction worker would have contact with groundwater 100 percent of the time they are at the site. Assuming that a construction worker would have contact with groundwater 4 hours a day for one working month (30 days) results in a hazard index of 0.2, which is less than the USEPA and CTDEP acceptable level (Attachment A.2). The HHRA guidance has been updated since the Phase II RI was prepared, but the changes in the HHRA guidance would not change the conclusions of the HHRA.

Basewide Groundwater Operable Unit Remedial Investigation Report

Groundwater at Site 2A was evaluated in the BGOURI (Tetra Tech, 2002). As part of the evaluation, concentrations of chemicals in groundwater were compared to USEPA and CTDEP screening criteria for direct contact (USEPA Region IX Preliminary Remedial Goals, USEPA Maximum Contaminant Levels, CTDEP Maximum Contaminant Levels, and CTDEP RSRs) and migration (CTDEP volatilization and surface water protection criteria). A copy of the comparisons is included in Attachment A.3. Maximum concentrations of acetone, arsenic, barium, and mercury exceeded the direct contact criteria (Table 5-4). Arsenic and mercury were detected at concentrations exceeding the surface water protection criteria (Table 5-5). Construction workers were identified as the only plausible receptor under current and expected future site use. The HHRA determined that risks for construction workers were less than USEPA and CTDEP acceptable levels (Table 5-8). The HHRA guidance has been updated since the BGOURI was prepared, but the changes in the HHRA guidance would not change the conclusions of the HHRA.

Year 7 Annual Groundwater Monitoring Report for Area A Landfill

The analytical sampling results for the two latest rounds of groundwater samples collected from upgradient wells, downgradient wells in Area A Downstream, and downgradient wells in the Area A Wetland (Rounds 18 and 19) at Site 2 are presented in Table 3-2 in Attachment A.4. Groundwater samples were analyzed for only PAHs and metals. VOCs are not considered to be chemicals of concern at the Area A Landfill based on the conclusions of previous investigations. Cadmium, copper, lead, and zinc were detected at concentrations which exceeded the surface water protection criteria. Cadmium, copper, and lead were not detected in groundwater samples collected during the BGOURI. Concentrations of zinc in the latest two rounds of sampling were higher than those detected in groundwater samples collected during the BGOURI. Concentrations of the other chemicals detected in the latest rounds of groundwater samples were comparable to or less than those detected during the BGOURI. While concentrations of cadmium, copper, lead, and zinc were higher in the latest round of groundwater samples, potential risks to construction workers would still be less than USEPA and CTDEP acceptable levels (Attachment A.5). Potential risks to residents using groundwater as a drinking water supply would exceed USEPA and CTDEP acceptable levels, although residential development of Site 2A is prohibited.

Vapor Intrusion Evaluation for Groundwater

Year 3 groundwater data from Site 2 were evaluated to determine if there were unacceptable risks associated with vapor intrusion into buildings (Tetra Tech, 2008). Concentrations of volatile organic compounds (VOCs) in groundwater were compared to screening criteria for vapor intrusion. The screening criteria were obtained from USEPA's *OSWER Draft Guidance for Evaluating the Vapor Intrusion into Indoor Air from Groundwater and Soils (Subsurface Vapor Intrusion Guidance), November 2002,* CTDEP's *Proposed Revisions - Connecticut's Remediation Standard Regulations Volatilization Criteria, March 2003,* and USEPA Region I (April 24, 2008). Concentrations of chloroform, tetrachloroethene, and trichloroethene at Site 2 exceeded the USEPA screening criterion. These chemicals were further evaluated using USEPA's Johnson and Ettinger Vapor Intrusion Model. Modeling results showed that cancer risks and hazard indices for residential and industrial scenarios were within USEPA and CTDEP acceptable levels at Site 2. Further evaluation against PRGs and ARARs showed that vapor intrusion is not an issue at Site 2. It was concluded that no further action was required for vapor intrusion issues at Site 2.

Conclusions

Historical and current information pertaining to Site 2 groundwater were reviewed to determine if Site 2 groundwater poses a threat to human health or the environment. The conclusions of this evaluation are the following:

- The HHRA for Site 2 Area A Landfill prepared during the BGOURI evaluated potential risks from exposures to groundwater by construction workers. The HHRA determined that risks for construction workers were within USEPA and CTDEP acceptable levels.
- The HHRA guidance has been revised since the BGOURI HHRA was prepared, but the changes in the guidance would not change the conclusions of the HHRA.
- Potential risks for construction workers exposed to Site 2 Area A Landfill groundwater would still be acceptable using the analytical results from the most recent rounds of groundwater sampling. Potential risks to residents using groundwater as a drinking water supply would exceed USEPA and CTDEP acceptable levels, although residential development of Site 2A is prohibited.

- Waste remains at Site 2 Area A Landfill under the landfill cap. Additional monitoring is required to demonstrate compliance.
- Dredge spoils remain at the Site 2 Area A Wetlands. There are no issues with groundwater at the Site 2 Area A Wetlands.
- The vapor intrusion evaluation for groundwater determined that risks from vapor intrusion were within USEPA and CTDEP acceptable levels for residential and industrial scenarios. The evaluation concluded that no further action was required for vapor intrusion issues at Site 2.
- Based on existing information, under current and expected land use, Site 2 groundwater does not póse a significant threat to human health or the environment. Adverse health effects are possible under hypothetical residential land use.

References

BRE (Brown & Root Environmental), 1997. Phase II Remedial Investigation, Naval Submarine Base, New London, Groton, Connecticut. Wayne, Pennsylvania, March.

CTDEP (Connecticut Department of Environmental Protection), 2003. Proposed Revision, Connecticut's Remediation Standard Regulations, Volatilization Criteria. Bureau of Water Management, Permitting, Enforcement and Remediation Division, Hartford. Connecticut. March.

ECC, 2007. Year 7 Annual Monitoring Report for Area A Landfill, Naval Submarine Base, New London, Groton, Connecticut. Marlborough, Massachusetts, September.

Tetra Tech (Tetra Tech NUS, Inc.), 2002. Basewide Groundwater Operable Unit Remedial Investigation, Naval Submarine Base - New London, Groton, Connecticut. King of Prussia, Pennsylvania, January.

Tetra Tech, 2008. Vapor Intrusion Evaluation for Groundwater at Operable Unit (OU) 9, Naval Submarine Base – New London, Groton, Connecticut. Pittsburgh, Pennsylvania. May 14.

USEPA (United States Environmental Protection Agency), 2002. Draft Guidance for Evaluating the Vapor Intrusion into Indoor Air. Office of Solid Waste and Emergency Response. EPA 530-F-02-052. November.

USEPA, 2004. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, (Part E, Supplemental Guidance for Dermal Risk Assessment). EPA/540/R/99/005, Office of Emergency and Remedial Response, Washington, D.C., July.

USEPA Region 9, 2004. Preliminary Remediation Goals, November.

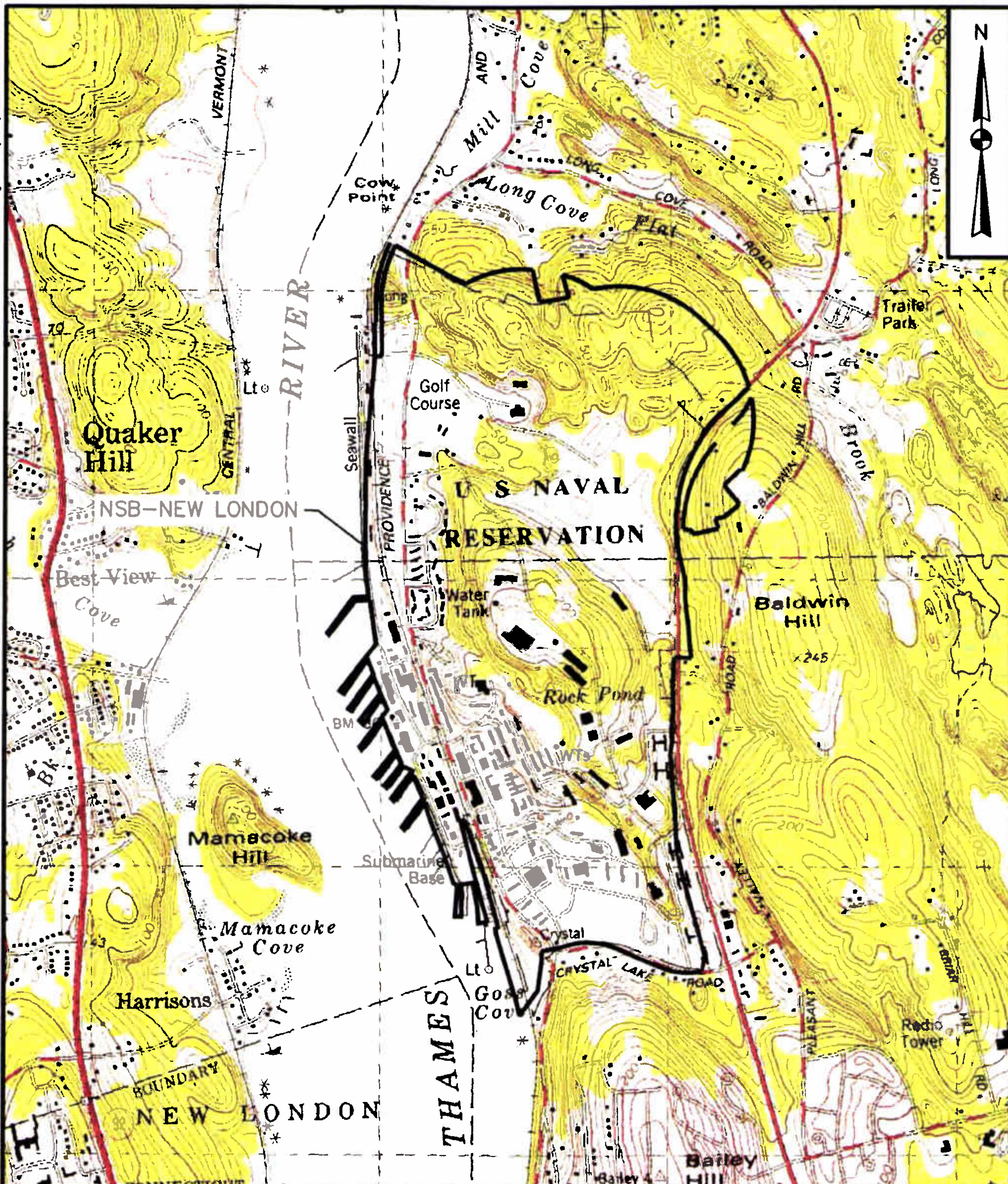
USEPA, 2005a. Guidelines for Carcinogen Risk Assessment. EPA/630/P-03/001B. Risk Assessment Forum, Washington, DC. March.

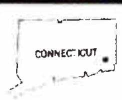
USEPA, 2005b. Supplemental Guidance of Assessing Susceptibility from Early-Life Exposure to Carcinogens. EPA/630/R-03/003F. Risk Assessment Forum, Washington, DC. March.

USEPA Region I, 2008. EPA Comments on the Basewide Groundwater Vapor Intrusion Analyses. Email from Kymberlee Kecker of USEPA Region I to Corey Rich of Tetra Tech NUS, Inc. April 24.

FIGURES

ACAD:0777cm01.dwg 04/25/07 DT PIT



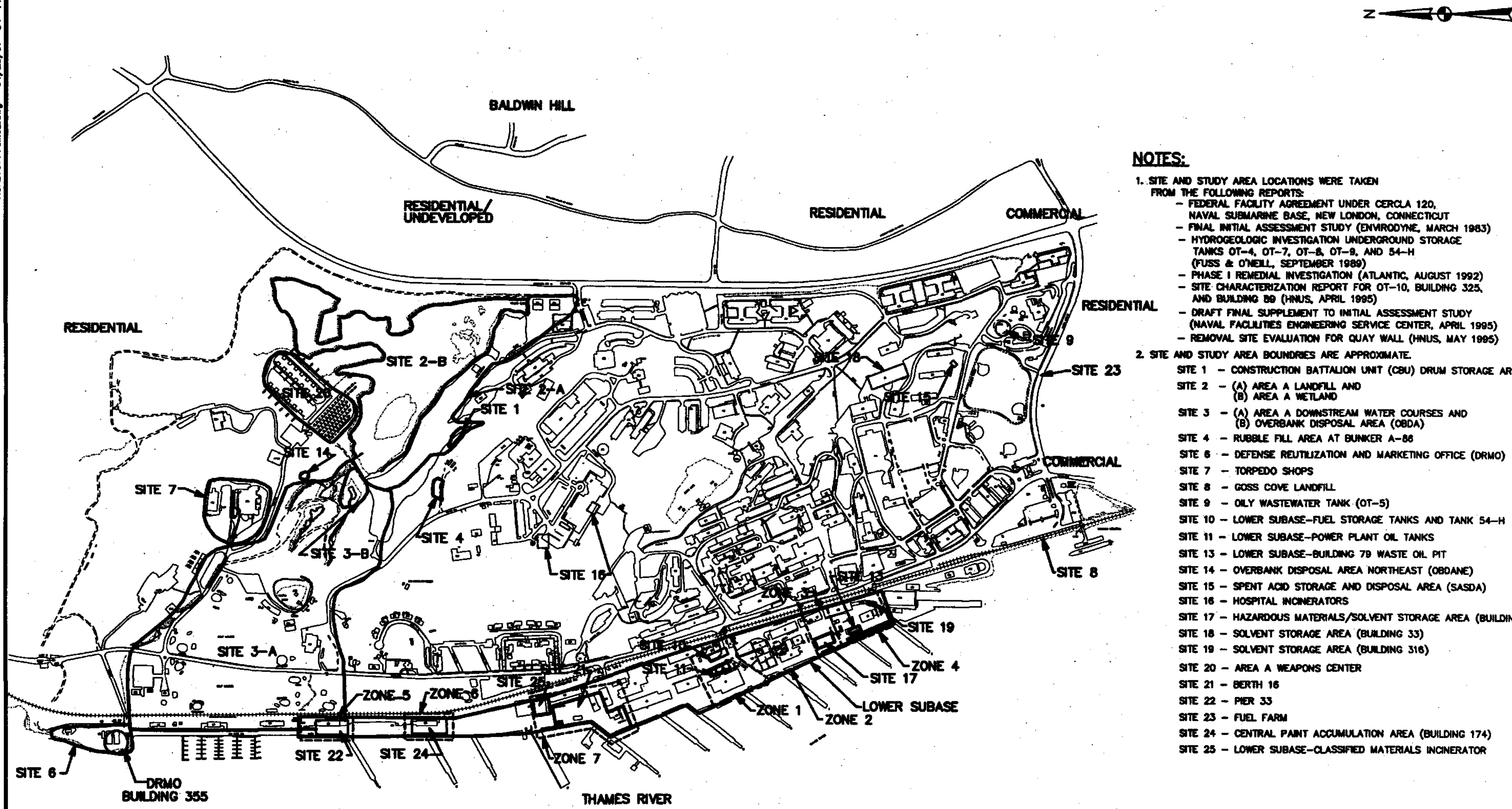


SOURCE: USGS QUADRANGLE MAP UNCASVILLE, CONNECTICUT, 1984

0 2000 4000
GRAPHIC SCALE IN FEET

DRAWN BY DT — DATE 4/25/07	Tetra Tech NUS, Inc.	FACILITY LOCATION MAP NSB-NLON GROTON, CONNECTICUT	CONTRACT NO. 0777
CHECKED BY NJB — DATE 4/27/07			OWNER NO. 073
REVISED BY — DATE			APPROVED BY CAR — DATE 4/27/07
SCALE AS NOTED			DRAWING NO. FIGURE 1-1 — REV. 0

FORM CADD NO. TTNUS-AV.DWG – REV 1 -9/10/98



NOTES:

1. SITE AND STUDY AREA LOCATIONS WERE TAKEN FROM THE FOLLOWING REPORTS:
   - FEDERAL FACILITY AGREEMENT UNDER CERCLA 120, NAVAL SUBMARINE BASE, NEW LONDON, CONNECTICUT
   - FINAL INITIAL ASSESSMENT STUDY (ENVIRODYNE, MARCH 1983)
   - HYDROGEOLOGIC INVESTIGATION UNDERGROUND STORAGE TANKS OT-4, OT-7, OT-8, OT-9, AND 54-H (FUSS & O'NEILL, SEPTEMBER 1989)
   - PHASE I REMEDIAL INVESTIGATION (ATLANTIC, AUGUST 1992)
   - SITE CHARACTERIZATION REPORT FOR OT-10, BUILDING 325, AND BUILDING 89 (HNUS, APRIL 1995)
   - DRAFT FINAL SUPPLEMENT TO INITIAL ASSESSMENT STUDY (NAVAL FACILITIES ENGINEERING SERVICE CENTER, APRIL 1995)
   - REMOVAL SITE EVALUATION FOR QUAY WALL (HNUS, MAY 1995)
2. SITE AND STUDY AREA BOUNDRIES ARE APPROXIMATE.
   - SITE 1 – CONSTRUCTION BATTALION UNIT (CBU) DRUM STORAGE AREA
   - SITE 2 – (A) AREA A LANDFILL AND (B) AREA A WETLAND
   - SITE 3 – (A) AREA A DOWNSTREAM WATER COURSES AND (B) OVERBANK DISPOSAL AREA (OBDA)
   - SITE 4 – RUBBLE FILL AREA AT BUNKER A-86
   - SITE 6 – DEFENSE REUTILIZATION AND MARKETING OFFICE (DRMO)
   - SITE 7 – TORPEDO SHOPS
   - SITE 8 – GOSS COVE LANDFILL
   - SITE 9 – OILY WASTEWATER TANK (OT-5)
   - SITE 10 – LOWER SUBASE-FUEL STORAGE TANKS AND TANK 54-H
   - SITE 11 – LOWER SUBASE-POWER PLANT OIL TANKS
   - SITE 13 – LOWER SUBASE-BUILDING 79 WASTE OIL PIT
   - SITE 14 – OVERBANK DISPOSAL AREA NORTHEAST (OBDANE)
   - SITE 15 – SPENT ACID STORAGE AND DISPOSAL AREA (SASDA)
   - SITE 16 – HOSPITAL INCINERATORS
   - SITE 17 – HAZARDOUS MATERIALS/SOLVENT STORAGE AREA (BUILDING 31)
   - SITE 18 – SOLVENT STORAGE AREA (BUILDING 33)
   - SITE 19 – SOLVENT STORAGE AREA (BUILDING 316)
   - SITE 20 – AREA A WEAPONS CENTER
   - SITE 21 – BERTH 16
   - SITE 22 – PIER 33
   - SITE 23 – FUEL FARM
   - SITE 24 – CENTRAL PAINT ACCUMULATION AREA (BUILDING 174)
   - SITE 25 – LOWER SUBASE-CLASSIFIED MATERIALS INCINERATOR

0 800 1600
GRAPHIC SCALE IN FEET

BASE MAP SOURCE: PREPARED BY THE NAVAL SUBMARINE BASE PUBLIC WORKS DEPT., ENGINEERING DIVISION. MARCH 2006, DRAWING NO. A-667.

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DT	4/26/07
CHECKED BY	DATE
NJB	4/27/07
REVISED BY	DATE
SCALE	AS NOTED

Tetra Tech NUS, Inc.

SITE LOCATION MAP
NSB-NLON
GROTON, CONNECTICUT

CONTRACT NO. 0777
OWNER NO. 073
APPROVED BY CAL DATE 4/27/07
DRAWING NO. FIGURE 1-2 REV. 0

ATTACHMENT A.1

TABLES FROM PHASE II RI REPORT

SUMMARY OF COC SELECTION
SITE 2 WETLAND - UNFILTERED GROUNDWATER (UG/L) (1)
NSB-NLON, GROTON, CONNECTICUT

Chemical	Frequency of Detection (2)	Range of Detection (2)	Location of Maximum	Range of Nondetects (3)	Federal MCL (4)	State MCL (5)	Risk-based COC Screening Level (6)	Selected as COC?	Rationale
Carbon disulfide	1/27	2	2WGW21S	5 - 10	-	-	100	N	2
Xylenes, total	1/27	1	2WGW5S	5 - 10	10000	10000	1200	N	2
2-Methylphenol	1/27	2	2WGW22D	10	-	-	180	N	2
4-Methylphenol	1/27	3	2WGW22D	10	-	-	18	N	2
Benzoic acid	6/27	0.5 - 12	2WGW3D	25 - 50	-	-	15000	N	2
Bis(2-ethylhexyl)phthalate	4/27	11 - 31	2WGW6D	10	6	6	4.8	Y	3
Di-n-butyl phthalate	1/27	1	2WGW3S	10	-	-	370	N	2
Di-n-octyl phthalate	2/27	0.6 - 3	2WGW3D	10	-	-	73	N	2
Diethyl phthalate	2/27	1	2WGW3D/2WGW3S	10	-	-	2900	N	2
Phenol	1/27	14	2WGW22D	10	-	-	2200	N	2
Aluminum	17/27	39.6 - 9910	2WGW6D	30 - 306	50 - 200 (7)	-	3700	~~Y~~ N	~~3~~ 5
Arsenic	12/26	1.9 - 109	2WGW21S	2 - 5	50	50	0.045	Y	3
Barium	27/27	15.5 - 904	2WGW3D	-	2000	2000	260	Y	3
Beryllium	4/27	1 - 3.6	2WGW6D	1	4	4	0.016	Y	3
Boron	13/19	89.7 - 3260	2WGW21S	21.3 - 43	-	-	330	Y	3
Cadmium	9/26	1.2 - 10.9	2WGW3D	1 - 4.8	5	5	1.8	Y	3
Calcium	27/27	5920 - 296000	2WGW21S	-	-	-	-	N	1
Chromium (total)	5/27	2.9 - 13.8	2WGW21S	3 - 5	100	100	18 (8)	N	2
Cobalt	12/27	2.1 - 37.5	2WGW6D	3 - 19.9	-	-	220	N	2
Copper	14/27	2.8 - 44.6	2WGW21S	1.1 - 17.2	1300 (9)	-	150	N	2
Cyanide	1/7	5	2WGW5S	5	200	200	73	N	2
Iron	26/27	85.1 - 131000	2WGW5S	105	300 (7)	-	1100	~~Y~~ N	~~3~~ 5
Lead	14/27	1.3 - 32.7	2WGW2D	1 - 15.1	15 (9)	-	-	Y	4
Magnesium	27/27	1340 - 1080000	2WGW21S	-	-	-	-	N	1
Manganese	27/27	2.3 - 9270	2WGW5S	-	50 (7)	-	~~18~~ 88	Y	3
Nickel	8/27	9.3 - 116	2WGW6D	7 - 25.6	100	100	73	Y	3
Potassium	25/27	557 - 815000	2WGW21S	1650 - 2290	-	-	-	N	1
Selenium	5/27	2.2 - 5.1	2WGW6D	1 - 5	50	50	18	N	2
Silver	1/27	1.5	2WGW3S	1 - 7.2	100 (7)	50	18	N	2

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Revisions
08/10/96
KAS

U2W_COC.XLS

SUMMARY OF COC SELECTION (Continued)
SITE 2 WETLAND - UNFILTERED GROUNDWATER (UG/L) (1)
NSB-NLON, GROTON, CONNECTICUT

Chemical	Frequency of Detection (2)	Range of Detection (2)	Location of Maximum	Range of Nondetects (3)	Federal MCL (4)	State MCL (5)	Risk-based COC Screening Level (6)	Selected as COC?	Rationale
Sodium	27/27	7580 - 8500000	2WGW21S	-	-	-	-	N	1
Thallium	5/22	4.6 - 15.2	2WGW21S	1 - 20	2	2	0.26 (10)	Y	3
Vanadium	4/27	2.7 - 26	2WGW21S	3 - 20	-	-	26	Y	3
Zinc	18/27	6.8 - 274	2WGW6D	2 - 26.7	5000 (7)	-	1100	N	2

Footnotes:

1 Results in ug/L unless otherwise noted.
2 Sample and duplicate counted as separate samples. Non-validated and rejected results are not used in risk assessment.
3 Sample-specific.
4 Maximum contaminant level. (USEPA, May 1995).
5 Title 19, Health and Safety, the Public Health Code of the State of Connecticut, Chapter II EnvironmentalHealth.
6 For tap water, based on a target hazard quotient of 0.1 or an incremental cancer risk of 1E-6 (USEPA Region III, October 20, 1995).
7 Secondary MCL (SMCL) based on aesthetic water qualities.
8 Hexavalent chromium.
9 Action Level.
10 Thallic oxide.

Rationale Designations:

1 No toxicity criteria available; exposure to chemical will be addressed in uncertainty section of risk assessment.
2 Maximum is less than the COC screening level.
3 Maximum is greater than or equal to the COC screening level.
4 No COC screening level available; maximum is greater than or equal to Federal Action Level.
5 USEPA Region I does not advocate quantitative evaluation of this chemical.

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U2W COC.XLS

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ATTACHMENT A.2

RE-EVALUATION OF PHASE II RI RISKS

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURES - PHASE II RI RE-EVALUATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Construction Workers	Adult	Site 2	Daevent	Dermally Absorbed Dose per Event	Calculated	mg/cm2-event	U.S. EPA, 2004	Dermally Absorbed Dose (mg/kg/day) =
				SA	Skin Surface Available for Contact	3300	cm2	U.S. EPA, 2004	
				EV	Event Frequency	1	events/day	(1)	DAevent x EV x EF x ED x SA
				ET	Exposure Time	4	hours/day	(1)	BW x AT
				EF	Exposure Frequency	30	days/year	(1)	
				ED	Exposure Duration	1	years	(1)	See text for calculation of DAevent.
				BW	Body Weight	70	kg	U.S. EPA, 1989	
				AT-C	Averaging Time (Cancer)	25550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	365	days	U.S. EPA, 1989	

Sources:

1 - Professional judgment.

U.S. EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

Unit Intake Calculations

Ingestion Intake = (IR-GW x EF x ED)/(BW x AT)

Dermal Intake = (SA x EV x EF x ED)/(BW x AT)

Cancer Ingestion Intake = NA

Noncancer Ingestion Intake = NA

Cancer Dermal Intake = 5.54E-02

Noncancer Dermal Intake = 3.87E+00

TABLE 4.2
INTERMEDIATE VARIABLES FOR CALCULATING DA(EVENT)
SITE 2 - PHASE II RI RE-EVALUATION
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Media	Dermal Absorption Fraction (soil)	FA	Kp		T(event)		Tau		T*		B
			Value	Value	Units	Value	Units	Value	Units	Value	Units	Value
Semivolatile Organic Compounds												
Bis(2-ethylhexyl)phthalate	Groundwater	NA	0.8	2.5E-02	cm/hr	4	hr	1.7E+01	hr	4.0E+01	hr	1.9E-01
Inorganics												
Antimony	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Arsenic	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Barium	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Beryllium	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Boron	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Cadmium	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Manganese	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Nickel	Groundwater	NA	1	2.0E-04	cm/hr	4	hr	NA	NA	NA	NA	NA
Thallium	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Vanadium	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA

Notes:
All values from EPA's Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final, July 2004.
FA = Fraction Absorbed Water
Kp = Dermal Permeability Coefficient of Compound in Water
T(event) = Event Duration
Tau = Lag Time
T* = Time to Reach Steady-State
B = Dimensionless Ratio of the Permeability Coefficient of a Compound Through the Stratum Corneum Relative to its Permeability Coefficient Across the Viable Epidermis
NA = Not applicable.

TABLE 5.1
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
SITE 2 - PHASE II RI RE-EVALUATION
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal[1]	Absorbed RfD for Dermal[2]		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD:Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Semivolatile Organic Compounds										
Bis(2-ethylhexyl)phthalate	Chronic	2.0E-02	mg/kg/day	1	2.0E-02	mg/kg/day	Liver	1000/1	IRIS	4/23/2008
Inorganics										
Antimony	Chronic	4.0E-04	mg/kg/day	0.15	6.0E-05	mg/kg/day	Blood	1000/1	IRIS	4/23/2008
Arsenic	Chronic	3.0E-04	mg/kg/day	1	3.0E-04	mg/kg/day	Skin, CVS	3/1	IRIS	4/23/2008
Barium	Chronic	2.0E-01	mg/kg/day	0.07	1.4E-02	mg/kg/day	Kidney	300/1	IRIS	4/23/2008
Beryllium	Chronic	2.0E-03	mg/kg/day	0.007	1.4E-05	mg/kg/day	GS	300/1	IRIS	4/23/2008
Boron	Chronic	2.0E-01	mg/kg/day	1	2.0E-01	mg/kg/day	Developmental	66/1	IRIS	4/23/2008
Cadmium	Chronic	5.0E-04	mg/kg/day	0.05	2.5E-05	mg/kg/day	Kidney	10/1	IRIS	4/23/2008
Manganese	Chronic	2.4E-02	mg/kg/day	0.04	9.6E-04	mg/kg/day	CNS	1/3	IRIS	4/23/2008
Nickel	Chronic	2.0E-02	mg/kg/day	0.04	8.0E-04	mg/kg/day	Body Weight	300/1	IRIS	4/23/2008
Thallium[3]	Chronic	7.0E-05	mg/kg/day	1	7.0E-05	mg/kg/day	Liver	3000	USEPA III	10/11/2007
Vanadium	Chronic	1.0E-03	mg/kg/day	0.026	2.6E-05	mg/kg/day	Kidney	300	USEPA III	10/11/2007

Notes:
1 - U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.
2 - Adjusted dermal RfD = Oral RfD x Oral Absorption Efficiency for Dermal.
3 - Weight adjustment of the IRIS value.

Definitions:
CNS = Central Nervous System
CVS = Cardiovascular system
EPA III = U.S. EPA Region 3 RBC Table, October 11, 2007.
GS = Gastrointestinal system
IRIS = Integrated Risk Information System
NA = Not Applicable

TABLE 6.1
CANCER TOXICITY DATA -- ORAL/DERMAL
SITE 2 - PHASE II RI RE-EVALUATION
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal[1]	Absorbed Cancer Slope Factor for Dermal[2]		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units		Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Semivolatile Organic Compounds								
Bis(2-ethylhexyl)phthalate	1.4E-02	$(mg/kg/day)^{-1}$	1	1.4E-02	$(mg/kg/day)^{-1}$	B2	IRIS	4/23/2008
Inorganics								
Antimony	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	1.5E+00	$(mg/kg/day)^{-1}$	1	1.5E+00	$(mg/kg/day)^{-1}$	A	IRIS	4/23/2008
Barium	NA	NA	NA	NA	NA	D	IRIS	4/23/2008
Beryllium	NA	NA	NA	NA	NA	B1	IRIS	4/23/2008
Boron	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	B1	IRIS	4/23/2008
Manganese	NA	NA	NA	NA	NA	D	IRIS	4/23/2008
Nickel	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
1 - U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.
2 - Adjusted cancer slope factor for dermal = Oral cancer slope factor / Oral Absorption Efficiency for Dermal.

IRIS = Integrated Risk Information System.
NA = Not Available.

EPA Group:
A - Human carcinogen.
B1 - Probable human carcinogen - indicates that limited human data are available.
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans .
C - Possible human carcinogen.
D - Not classifiable as a human carcinogen.
E - Evidence of noncarcinogenicity.

TABLE 7.1.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURES - PHASE II RI RE-EVALUATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Construction Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Site 2	Dermal	Bis(2-ethylhexyl)phthalate	16.0	ug/L	4.0E-07	(mg/kg/day)	1.4E-02	(mg/kg/day)$^{-1}$	5.6E-09	2.8E-05	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.001
				Antimony	8.60	ug/L	1.9E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.3E-07	(mg/kg/day)	6.0E-05	(mg/kg/day)	0.002
				Arsenic	82.6	ug/L	1.8E-08	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	2.7E-08	1.3E-06	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.004
				Barium	610	ug/L	1.4E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	9.5E-06	(mg/kg/day)	1.4E-02	(mg/kg/day)	0.0007
				Beryllium	1.50	ug/L	3.3E-10	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.3E-08	(mg/kg/day)	1.4E-05	(mg/kg/day)	0.002
				Boron	3170	ug/L	7.0E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	4.9E-05	(mg/kg/day)	2.0E-01	(mg/kg/day)	0.0002
				Cadmium	6.60	ug/L	1.5E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.0E-07	(mg/kg/day)	2.5E-05	(mg/kg/day)	0.004
				Manganese	8430	ug/L	1.9E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.3E-04	(mg/kg/day)	9.6E-04	(mg/kg/day)	0.1
				Nickel	44.6	ug/L	2.0E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.4E-07	(mg/kg/day)	8.0E-04	(mg/kg/day)	0.0002
				Thallium	8.90	ug/L	2.0E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.4E-07	(mg/kg/day)	7.0E-05	(mg/kg/day)	0.002
				Vanadium	25.5	ug/L	5.6E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	4.0E-07	(mg/kg/day)	2.6E-05	(mg/kg/day)	0.02
			Exp. Route Total								3.3E-08					0.2
		Exposure Point Total									3.3E-08					0.2
	Exposure Medium Total										3.3E-08					0.2
Medium Total											3.3E-08					0.2
										Total of Receptor Risks Across All Media	3.3E-08				Total of Receptor Hazards Across All Media	0.2

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES - PHASE II RI RE-EVALUATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Construction Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 2	Bis(2-ethylhexyl)phthalate	--	--	6E-09	--	6E-09	Liver	--	--	0.001	0.001
			Antimony	--	--	--	--	--	Blood	--	--	0.002	0.002
			Arsenic	--	--	3E-08	--	3E-08	Skin, CVS	--	--	0.004	0.004
			Barium	--	--	--	--	--	Kidney	--	--	0.0007	0.0007
			Beryllium	--	--	--	--	--	GS	--	--	0.002	0.002
			Boron	--	--	--	--	--	Developmental	--	--	0.0002	0.0002
			Cadmium	--	--	--	--	--	Kidney	--	--	0.004	0.004
			Manganese	--	--	--	--	--	CNS	--	--	0.1	0.1
			Nickel	--	--	--	--	--	Body Weight	--	--	0.0002	0.0002
			Thallium	--	--	--	--	--	Liver	--	--	0.002	0.002
			Vanadium	--	--	--	--	--	Kidney	--	--	0.02	0.02
			Chemical Total	--	--	3E-08	--	3E-08		--	--	0.2	0.2
		Exposure Point Total						3E-08					0.2
	Exposure Medium Total							3E-08					0.2
Medium Total								3E-08					0.2
Receptor Total							Receptor Risk Total	3E-08				Receptor HI Total	0.2

Total Blood HI	0.002
Total Body Weight HI	0.0002
Total CNS HI	0.1
Total CVS HI	0.004
Total GS HI	0.002
Total Kidney HI	0.02
Total Liver HI	0.003
Total Skin HI	0.004
Total Developmental HI	0.0002

ATTACHMENT A.3
TABLES FROM BASEWIDE GROUNDWATER OPERABLE UNIT REPORT

TABLE 5-4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 2
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Landfill and Wetlands (Site 2)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics																
78-93-3	2-BUTANONE	2	J	26		ug/L	2WGW39DS-04	5/11	5	26	NA	190 N	400 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
67-64-1	ACETONE	3	J	120		ug/L	2WGW39DS-04	8/11	5	120	NA	61 N	700 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
75-15-0	CARBON DISULFIDE	2		7		ug/L	2WGW45DS-04	3/11	1 - 4	7	NA	100 N	700 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
100-41-4	ETHYLBENZENE	0.3	J	0.3	J	ug/L	2WGW39DS-04	1/11	1	0.3	NA	130 N	700 700 700	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
108-88-3	TOLUENE	0.4	J	0.6	J	ug/L	2WGW39DS-04	2/11	1	0.6	NA	72 N	1000 1000 1000	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
79-01-6	TRICHLOROETHENE	1	J	1	J	ug/L	3GW37S-04	1/11	1	1	NA	1.6 C	5 5 5	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
Semivolatile Organics																
	3&4-METHYLPHENOL	0.75	J	3.5	J	ug/L	2WGW39DS-04	3/11	5.1 - 6.2	3.5	NA	18 N	35 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
65-85-0	BENZOIC ACID	2.3	J	2.3	J	ug/L	2WGW39DS-04	1/10	20 - 25	2.3	NA	15000 N	50000 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
108-95-2	PHENOL	2.5	J	2.5	J	ug/L	2WGW39DS-04	1/11	5 - 6.2	2.5	NA	2200 N	4000 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
Pesticides																
72-54-8	4,4'-DDD	0.042	J	0.058	J	ug/L	2WGW47DS-04	1/11	0.02 - 0.029	0.058	NA	0.28 C	0.15 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
Total Metals																
7429-90-5	ALUMINUM	220		292		ug/L	2WGW47DS-04-D	1/11	69.1 - 138	292	3560	3600 N	N/A 50-200 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI, BKG
7440-38-2	ARSENIC	16.1	J	30.4	J	ug/L	2WGW47DS-04-D	4/11	2.7 - 10.1	30.4	1.92	0.045 C	50 50 50	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-39-3	BARIUM	28.4	J	920		ug/L	2WGW47DS-04	11/11	N/A	920	227	260 N	1000 2000 2000	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-70-2	CALCIUM	30700		334000		ug/L	2WGW46DS-04	11/11	N/A	334000	188000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7440-47-3	CHROMIUM	1.4	J	11.9	J	ug/L	2WGW46DS-04	7/11	1.3	11.9	49.9	11 N	50 100 100	CTDEP RSR FED-MCL CTDEP-MCL	NO	BKG
7440-48-4	COBALT	0.95	J	13.4		ug/L	2WGW47DS-04, 2WGW47DS-04-D	3/11	0.94	13.4	48.6	220 N	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7439-89-6	IRON	188		234000		ug/L	2WGW47DS-04	10/11	112	234000	28200	1100 N	N/A 300 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI

TABLE 5-4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 2
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Landfill and Wetlands (Site 2)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
7439-95-4	MAGNESIUM	5530		1020000		ug/L	2WGW46DS-04	11/11	N/A	1020000	191000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7439-96-5	MANGANESE	36.6		8960		ug/L	2WGW47DS-04	11/11	N/A	8960	11700	88 N	N/A 50 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
7439-97-6	MERCURY	0.12	J	1.5		ug/L	2WGW47DS-04-D	2/11	0.1	1.5	ND	0.36 N	2 2 2	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-02-0	NICKEL	7.4		7.4		ug/L	2WGW38DS-04	1/11	1.2 - 5.7	7.4	32.2	73 N	100 N/A 100	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-09-7	POTASSIUM	5790	J	361000	J	ug/L	2WGW46DS-04	11/11	N/A	361000	70800	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7440-23-5	SODIUM	67000		7930000		ug/L	2WGW46DS-04	11/11	N/A	7930000	1900000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7440-62-2	VANADIUM	9.5	J	14.6	J	ug/L	2WGW45DS-04	3/11	0.71 - 7	14.6	10.2	26 N	50 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
7440-66-6	ZINC	6.1	J	11.1	J	ug/L	2WGW46DS-04	4/11	3.1 - 6.8	11.1	131	1100 N	5000 5000 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL, BKG
Dissolved Metals																
7440-38-2	ARSENIC, FILTERED	29.3	J	35.5	J	ug/L	2WGW47DS-04-F	2/10	2.7 - 13.8	35.5	1.92	0.045 C	50 50(9) 50	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-39-3	BARIUM, FILTERED	28.2	J	1070		ug/L	2WGW47DS-04-F	10/10	N/A	1070	227	260 N	1000 2000 2000	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-70-2	CALCIUM, FILTERED	32000		327000		ug/L	2WGW46DS-04-F	10/10	N/A	327000	NA	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7440-47-3	CHROMIUM, FILTERED	1.8	J	13.6	J	ug/L	2WGW46DS-04-F	5/10	1.3	13.6	49.9	11 N	50 100 100	CTDEP RSR FED-MCL CTDEP-MCL	NO	BKG
7440-48-4	COBALT, FILTERED	0.99	J	14.5		ug/L	2WGW47DS-04-F	4/10	0.94 - 1.1	14.5	48.6	220 N	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7439-89-6	IRON, FILTERED	219		263000		ug/L	2WGW47DS-04-F	9/10	167	263000	28200	1100 N	N/A 300 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI
7439-95-4	MAGNESIUM, FILTERED	5530		1060000		ug/L	2WGW46DS-04-F	10/10	N/A	1060000	191000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7439-96-5	MANGANESE, FILTERED	228		10100		ug/L	2WGW47DS-04-F	10/10	N/A	10100	11700	88 N	N/A 50 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
7439-97-6	MERCURY, FILTERED	0.12	J	1.3		ug/L	2WGW47DS-04-F-D	2/10	0.1	1.3	ND	0.36 N	2 2 2	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
7440-09-7	POTASSIUM, FILTERED	5090	J	360000	J	ug/L	2WGW46DS-04-F	10/10	N/A	360000	70800	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT
7440-23-5	SODIUM, FILTERED	67300		7940000		ug/L	2WGW46DS-04-F	10/10	N/A	7940000	1900000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT

TABLE 5-4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 2
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Landfill and Wetlands (Site 2)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
7440-62-2	VANADIUM, FILTERED	9.3	J	9.3	J	ug/L	2WGW43DS-04-F	1/10	0.71 - 6.8	9.3	10.2	26 N	50 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-66-6	ZINC, FILTERED	13.6	J	18.7	J	ug/L	2WGW47DS-04-F-D	2/10	3.2 - 7.6	18.7	131	1100 N	5000 5000 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL, BKG
Miscellaneous Parameters																
	ALKALINITY	120000		2420000		mg/L	2WGW46DS-04	11/11	N/A	2420000	1950	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
	CHEMICAL OXYGEN DEMAND	41600		2410000		mg/L	2WGW46DS-04	10/11	20,000	2410000	570	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
	CHLORIDE	107000	J	16800000	J	mg/L	2WGW46DS-04	11/11	N/A	16800000	4540	N/A	N/A 250 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NV
	HARDNESS as CaCO3	110000		5030000		mg/L	2WGW46DS-04	11/11	N/A	5030000	ND	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
	SULFATE	20000		989000		mg/L	2WGW40DS-04	8/11	20,000	989000	45.2	N/A	N/A 250 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NV
	TOTAL DISSOLVED SOLIDS	336000		29400000		mg/L	2WGW46DS-04	11/11	N/A	29400000	6260	N/A	N/A 500 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NV
	TOTAL ORGANIC CARBON	4000		65200		mg/L	2WGW41DS-04	11/11	N/A	65200	37.7	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
	TOTAL SUSPENDED SOLIDS	22000	J	181000	J	mg/L	2WGW47DS-04	9/11	4,000	181000	236	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data.
5 The risk-based COPC screening level for tap water use is presented. The value is based on a target hazard quotient of 0.1 for noncarcinogens (denoted with a "N" flag) or an incremental cancer risk of 1E-6 for carcinogens (denoted with a "C" flag) (USEPA, Region IX, November 2000).
6 The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
7 Pyrene is used as a surrogate for phenanthrene.
8 Value is for hexavalent chromium.
9 The US EPA has approved a new MCL for arsenic of 10 ug/L. The new MCL goes into effect in 2006. The reduction in the MCL does not impact the human health risk assessment.

Associated Samples:

2WGW38DS-04	2WGW42DS-04	2WGW45DS-04-F	3GW37S-04
2WGW39DS-04	2WGW42DS-04-F	2WGW46DS-04	3GW37S-04-F
2WGW39DS-04-F	2WGW43DS-04	2WGW46DS-04-F	
2WGW40DS-04	2WGW43DS-04-F	2WGW47DS-04	
2WGW40DS-04-F	2WGW44DS-04	2WGW47DS-04-D	
2WGW41DS-04	2WGW44DS-04-F	2WGW47DS-04-F	
2WGW41DS-04-F	2WGW45DS-04	2WGW47DS-04-F-D	

Definitions:

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COPC = Chemical of Potential Concern.
J = Estimated Value.
N = Noncarcinogen.
N/A = Not Applicable.
FED-MCL = Federal Maximum Contaminant Level (USEPA, August 2000).
FED-SMCL = Federal Secondary Maximum Contaminant Level (USEPA, August 2000).
FED-AL = Federal Action Level (USEPA, August 2000).
CTDEP-RSR = Connecticut DEP Remediation Standard Regulations, 1996.
CTDEP-MCL = Connecticut Maximum Contaminant Level.

Rationale Codes:

For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BKG = Within Background Levels.
BSL = Below COPC Screening Level/ARAR/TBC.
NUT = Essential Nutrient.
NTX = No Toxicity Information.
EPAI = USEPA Region one does not advocate evaluation of this chemical.
NV = These compounds are not evaluated in the HHRA and are only presented for informational purposes.

TABLE 5-5

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 2
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Landfill and Wetlands (Site 2)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Surface Water Protection Criteria(5)	Volatilization Criteria(5)	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics															
78-93-3	2-BUTANONE	2	J	26		ug/L	2WGW39DS-04	5/11	5	26	N/A	N/A	50000	NO	BSL
67-64-1	ACETONE	3	J	120		ug/L	2WGW39DS-04	8/11	5	120	N/A	N/A	50000	NO	BSL
75-15-0	CARBON DISULFIDE	2		7		ug/L	2WGW45DS-04	3/11	1 - 4	7	N/A	N/A	N/A	NO	NTX
100-41-4	ETHYLBENZENE	0.3	J	0.3	J	ug/L	2WGW39DS-04	1/11	1	0.3	N/A	580000	50000	NO	BSL
108-88-3	TOLUENE	0.4	J	0.6	J	ug/L	2WGW39DS-04	2/11	1	0.6	N/A	4000000	23500	NO	BSL
79-01-6	TRICHLOROETHENE	1	J	1	J	ug/L	3GW37S-04	1/11	1	1	N/A	2340	219	NO	BSL
Semivolatile Organics															
	3&4-METHYLPHENOL	0.75	J	3.5	J	ug/L	2WGW39DS-04	3/11	5.1 - 6.2	3.5	N/A	N/A	N/A	NO	NTX
65-85-0	BENZOIC ACID	2.3	J	2.3	J	ug/L	2WGW39DS-04	1/10	20 - 25	2.3	N/A	N/A	N/A	NO	NTX
108-95-2	PHENOL	2.5	J	2.5	J	ug/L	2WGW39DS-04	1/11	5 - 6.2	2.5	N/A	92000000	N/A	NO	BSL
Pesticides															
72-54-8	4,4'-DDD	0.042	J	0.058	J	ug/L	2WGW47DS-04	1/11	0.02 - 0.029	0.058	N/A	N/A	N/A	NO	NTX
Total Metals															
7429-90-5	ALUMINUM	220		292		ug/L	2WGW47DS-04-D	1/11	69.1 - 138	292	3560	N/A	N/A	NO	BKG
7440-38-2	ARSENIC	16.1	J	30.4	J	ug/L	2WGW47DS-04-D	4/11	2.7 - 10.1	30.4	1.92	4	N/A	YES	ASL
7440-39-3	BARIUM	28.4	J	920		ug/L	2WGW47DS-04	11/11	N/A	920	227	N/A	N/A	NO	NTX
7440-70-2	CALCIUM	30700		334000		ug/L	2WGW46DS-04	11/11	N/A	334000	188000	N/A	N/A	NO	NTX
7440-47-3	CHROMIUM VI	1.4	J	11.9	J	ug/L	2WGW46DS-04	7/11	1.3	11.9	49.9	110	N/A	NO	BSL, BKG
7440-48-4	COBALT	0.95	J	13.4		ug/L	2WGW47DS-04, 2WGW47DS-04-D	3/11	0.94	13.4	48.6	N/A	N/A	NO	BKG
7439-89-6	IRON	188		234000		ug/L	2WGW47DS-04	10/11	112	234000	28200	N/A	N/A	NO	NTX
7439-95-4	MAGNESIUM	5530		1020000		ug/L	2WGW46DS-04	11/11	N/A	1020000	191000	N/A	N/A	NO	NTX
7439-96-5	MANGANESE	36.6		8960		ug/L	2WGW47DS-04	11/11	N/A	8960	11700	N/A	N/A	NO	BKG
7439-97-6	MERCURY	0.12	J	1.5		ug/L	2WGW47DS-04-D	2/11	0.1	1.5	ND	0.4	N/A	YES	ASL
7440-02-0	NICKEL	7.4		7.4		ug/L	2WGW38DS-04	1/11	1.2 - 5.7	7.4	32.2	880	N/A	NO	BSL, BKG
7440-09-7	POTASSIUM	5790	J	361000	J	ug/L	2WGW46DS-04	11/11	N/A	361000	70800	N/A	N/A	NO	NTX
7440-23-5	SODIUM	67000		7930000		ug/L	2WGW46DS-04	11/11	N/A	7930000	1900000	N/A	N/A	NO	NTX
7440-62-2	VANADIUM	9.5	J	14.6	J	ug/L	2WGW45DS-04	3/11	0.71 - 7	14.6	10.2	N/A	N/A	NO	NTX
7440-66-6	ZINC	6.1	J	11.1	J	ug/L	2WGW46DS-04	4/11	3.1 - 6.8	11.1	131	123	N/A	NO	BSL, BKG
Dissolved Metals															
7440-38-2	ARSENIC, FILTERED	29.3	J	35.5	J	ug/L	2WGW47DS-04-F	2/10	2.7 - 13.8	35.5	1.92	4	N/A	YES	ASL
7440-39-3	BARIUM, FILTERED	28.2	J	1070		ug/L	2WGW47DS-04-F	10/10	N/A	1070	227	N/A	N/A	NO	NTX
7440-70-2	CALCIUM, FILTERED	32000		327000		ug/L	2WGW46DS-04-F	10/10	N/A	327000	188000	N/A	N/A	NO	NTX
7440-47-3	CHROMIUM, FILTERED	1.8	J	13.6	J	ug/L	2WGW46DS-04-F	5/10	1.3	13.6	49.9	110	N/A	NO	BSL, BKG
7440-48-4	COBALT, FILTERED	0.99	J	14.5		ug/L	2WGW47DS-04-F	4/10	0.94 - 1.1	14.5	48.6	N/A	N/A	NO	BKG
7439-89-6	IRON, FILTERED	219		263000		ug/L	2WGW47DS-04-F	9/10	167	263000	28200	N/A	N/A	NO	NTX
7439-95-4	MAGNESIUM, FILTERED	5530		1060000		ug/L	2WGW46DS-04-F	10/10	N/A	1060000	191000	N/A	N/A	NO	NTX
7439-96-5	MANGANESE, FILTERED	228		10100		ug/L	2WGW47DS-04-F	10/10	N/A	10100	11700	N/A	N/A	NO	BKG
7439-97-6	MERCURY, FILTERED	0.12	J	1.3		ug/L	2WGW47DS-04-F-D	2/10	0.1	1.3	ND	0.4	N/A	YES	ASL
7440-09-7	POTASSIUM, FILTERED	5090	J	360000	J	ug/L	2WGW46DS-04-F	10/10	N/A	360000	70800	N/A	N/A	NO	NTX
7440-23-5	SODIUM, FILTERED	67300		7940000		ug/L	2WGW46DS-04-F	10/10	N/A	7940000	1900000	N/A	N/A	NO	NTX
7440-62-2	VANADIUM, FILTERED	9.3	J	9.3	J	ug/L	2WGW43DS-04-F	1/10	0.71 - 6.8	9.3	10.2	N/A	N/A	NO	BKG
7440-66-6	ZINC, FILTERED	13.6	J	18.7	J	ug/L	2WGW47DS-04-F-D	2/10	3.2 - 7.6	18.7	131	123	N/A	NO	BSL, BKG
Miscellaneous Parameters															
	ALKALINITY	120000		2420000		mg/L	2WGW46DS-04	11/11	N/A	2420000	1950	N/A	N/A	NO	NTX
	CHEMICAL OXYGEN DEMAND	41600		2410000		mg/L	2WGW46DS-04	10/11	20,000	2410000	570	N/A	N/A	NO	NTX

TABLE 5-5

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 2
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Landfill and Wetlands (Site 2)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Surface Water Protection Criteria(5)	Volatilization Criteria(5)	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
	CHLORIDE	107000	J	16800000	J	mg/L	2WGW46DS-04	11/11	N/A	16800000	4540	N/A	N/A	NO	NTX
	HARDNESS as CaCO3	110000		5030000		mg/L	2WGW46DS-04	11/11	N/A	5030000	ND	N/A	N/A	NO	NTX
	SULFATE	20000		989000		mg/L	2WGW40DS-04	8/11	20,000	989000	45.2	N/A	N/A	NO	NTX
	TOTAL DISSOLVED SOLIDS	336000		29400000		mg/L	2WGW46DS-04	11/11	N/A	29400000	6260	N/A	N/A	NO	NTX
	TOTAL ORGANIC CARBON	4000		65200		mg/L	2WGW41DS-04	11/11	N/A	65200	37.7	N/A	N/A	NO	NTX
	TOTAL SUSPENDED SOLIDS	22000	J	181000	J	mg/L	2WGW47DS-04	9/11	4,000	181000	236	N/A	N/A	NO	NTX

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data.
5 Connecticut DEP Surface Water Protection criteria.
6 Connecticut DEP Volatilization criteria.
7 The chemical is selected as a COPC if the maximum detected concentration exceeds the CTDEP surface water protection or volatilization criteria.

Associated Samples:

2WGW38DS-04
2WGW39DS-04
2WGW39DS-04-F
2WGW40DS-04
2WGW40DS-04-F
2WGW41DS-04
2WGW41DS-04-F
2WGW42DS-04
2WGW42DS-04-F
2WGW43DS-04
2WGW43DS-04-F
2WGW44DS-04
2WGW44DS-04-F
2WGW45DS-04
2WGW45DS-04-F
2WGW46DS-04
2WGW46DS-04-F
2WGW47DS-04
2WGW47DS-04-D
2WGW47DS-04-F
2WGW47DS-04-F-D
3GW37S-04
3GW37S-04-F

Definitions:

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.

Rationale Codes:

For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BKG = Within Background Levels.
BSL = Below COPC Screening Level/ARAR/TBC.
NTX = No Toxicity Information.

TABLE 5-8

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 2
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
REASONABLE MAXIMUM EXPOSURES								
Construction Worker	Groundwater	Dermal Contact	0.0E+00	- -	- -	- -	0.00008	- -
CENTRAL TENDENCY EXPOSURES								
Construction Worker	Groundwater	Dermal Contact	0.0E+00	- -	- -	- -	0.00004	- -

ATTACHMENT A.4

TABLES FROM YEAR 7 ANNUAL GROUNDWATER MONITORING REPORT FOR AREA A LANDFILL

TABLE 3-2
GROUNDWATER ANALYTICAL RESULTS SUMMARY, ROUNDS 18 AND 19
YEAR 7 ANNUAL GROUNDWATER MONITORING REPORT
AREA A LANDFILL, NSB-NLON, GROTON, CONNECTICUT

Chemical	Primary Monitoring Criterion (1)	NSB-NLON Background Concentration(2)	2LMW20S Round 18 8/25/2006	2LMW20S Round 19 12/13/2006	2WMW21S Round 18 8/28/2006	2WMW21S Round 19 12/14/2006	2WMW40DS Round 18 8/30/2006	2WMW40DS Round 19 12/13/2006
SVOCs (µg/L)								
BENZO(A)ANTHRACENE	0.3	--			0.039 U	0.04 U	0.04 U	0.041 U
BENZO(A)PYRENE	0.3	--			0.041 U	0.042 U	0.042 U	0.043 U
BENZO(B)FLUORANTHENE	0.3	--			0.052 U	0.053 U	0.053 U	0.054 U
BENZO(K)FLUORANTHENE	0.3	--			0.037 U	0.038 U	0.038 U	0.039 U
BIS(2-ETHYLHEXYL)PHTHALATE	59	--			6.4 U	1.8 U	6.8 U	1.8 U
PHENANTHRENE	0.3	--			**0.11 J**	**0.061 J**	**0.035 J**	0.033 U
Inorganics (Total) (µg/L)								
ARSENIC	150	1.92			**5.3 J**	**12.8**	**5.1 J**	**18.8**
BERYLLIUM	4	NA			0.5 U	0.3 U	0.5 UJ	0.3 U
CADMIUM	0.25 (3)	NA			0.034 U	0.17 U	0.034 U	0.17 U
CHROMIUM	11	49.9			**7.7 J**	**7.3**	**3.8 J**	**7.3**
COPPER	4.8	107	Dry @ 16.65'	Dry @ 16.60'	**6.4 J**	**14**	**6 J**	**7.5**
LEAD	1.2	6.63			**0.29 J**	**1.17 J**	0.07 UJ	**0.7 J**
ZINC	65	131			**13.4**	**60.5**	**12.2**	**61**
Inorganics (Dissolved) (µg/L)								
ARSENIC	150	2.55			**4.6 J**	**14**	**6.9 J**	**7**
BERYLLIUM	4	NA			0.1 UJ	0.3 U	0.1 U	0.3 U
CADMIUM	0.25 (3)	NA			0.034 U	0.034 U	0.034 U	0.034 U
CHROMIUM	11	16			**6.4 J**	**6**	**2.9 J**	**7**
COPPER	4.8	39.4			**68.2 J**	**9**	**14.1 J**	**9**
LEAD	1.2	2.52			0.11 U	0.1 U	0.08 U	0.2 U
ZINC	65	109			**27 J**	**24**	**16.5 J**	**55**

Notes:

(1) Based on Federal Ambient Water Quality Criteria for protection of aquatic life (chronic, freshwater) (USEPA, 1999) and Connecticut Water Quality Criteria for protection of human health from consumption of organisms (CTDEP, 1997).

(2) Total/Dissolved background concentration taken from Basewide Groundwater Remedial Investigation Report (TtNUS, January, 1996).

(3) The reporting limit from the laboratory exceeds the primary monitoring criterion for this analyte.

-- = Not analyzed for in background samples.

DUP = Field duplicate sample

J = Estimated value

µg/L = micrograms per liter

NA = Not available

NSB-NLON = Naval Submarine Base New London

SVOCs = Semivolatile organic compounds

U = Undetected value

Bold type denotes analyte detection.

Shaded boxes denote exceedances of primary or secondary monitoring criterion and/or background groundwater concentrations.

TABLE 3-2
GROUNDWATER ANALYTICAL RESULTS SUMMARY, ROUNDS 18 AND 19
YEAR 7 ANNUAL GROUNDWATER MONITORING REPORT
AREA A LANDFILL, NSB-NLON, GROTON, CONNECTICUT

Chemical	Primary Monitoring Criterion [1]	NSB-NLON Background Concentration [2]	2WMW42DS Round 18 8/29/2006	2WMW42DS (DUP) Round 18 8/29/2006	2WMW42DS Round 19 12/12/2006	2WMW42DS (DUP) Round 19 12/12/2006	2WMW43DS Round 18 8/24/2006	2WMW43DS Round 19 12/12/2006
SVOCs (µg/L)								
BENZO(A)ANTHRACENE	0.3	--	0.19 U	0.039 U	0.038 U	0.04 U	0.038 U	**0.073** J
BENZO(A)PYRENE	0.3	--	0.2 U	0.041 U	0.04 U	0.042 U	0.04 U	0.04 U
BENZO(B)FLUORANTHENE	0.3	--	0.25 U	0.051 U	0.05 U	0.053 U	0.05 U	0.05 U
BENZO(K)FLUORANTHENE	0.3	--	0.18 U	0.037 U	0.036 U	0.038 U	0.036 U	0.036 U
BIS(2-ETHYLHEXYL)PHTHALATE	59	--	7 U	6.5 U	1.6 U	1.7 U	6.8 U	1.6 U
PHENANTHRENE	0.3	--	0.16 U	0.032 U	**0.056** J	**0.04** J	0.031 U	**0.054** J
Inorganics (Total) (µg/L)								
ARSENIC	150	1.92	**11.6** J	**8.3** J	**25.3** J	**4.4** J	**7.1** J	**17.3**
BERYLLIUM	4	NA	0.5 U	0.5 U	0.3 U	0.3 U	0.5 U	0.0003 U
CADMIUM	0.25 [3]	NA	0.034 U	0.034 U	0.17 U	0.05 U	0.034 U	0.00024 U
CHROMIUM	11	49.9	**5.9** J	**8.2** J	**9.5**	**6.9**	**7.8** J	**8.5**
COPPER	4.8	107	**30.8** J	**6.3** J	**8.8**	**5.5**	**17.9** J	**5.2**
LEAD	1.2	6.63	**1.5** J	**0.45** J	**14.3** J	**2.6** J	**1.1** J	**0.39** J
ZINC	65	131	**19.1**	**16.9**	**67.5**	**51.5**	**37.3**	**41.7**
Inorganics (Dissolved) (µg/L)								
ARSENIC	150	2.55	**8.5** J	0.034 U	**13.7** J	**2** J	**13.2** J	**10**
BERYLLIUM	4	NA	0.1 UJ	0.1 UJ	0.3 U	0.3 U	0.1 UJ	0.3 U
CADMIUM	0.25 [3]	NA	0.034 U	0.034 U	0.034 U	0.034 U	0.034 U	0.034 U
CHROMIUM	11	16	**5.3** J	**1.9** J	**4.3** J	**2** J	**5.4** J	**6**
COPPER	4.8	39.4	**5.9** J	**2.6** J	**5.8** J	**1** J	**9** J	**8**
LEAD	1.2	2.52	0.04 U	0.04 U	**0.06** J	0.1 UJ	0.09 U	**0.3** J
ZINC	65	109	**15.8** J	**8.3** J	**17.3** J	6 UJ	**29.8**	**59**

Notes:

(1) Based on Federal Ambient Water Quality Criteria for protection of aquatic life (chronic, freshwater) (USEPA, 1999) and Connecticut Water Quality Criteria for protection of human health from consumption of organisms (CTDEP, 1997).

(2) Total/Dissolved background concentration taken from Basewide Groundwater Remedial Investigation Report (TtNUS, January, 1996).

(3) The reporting limit from the laboratory exceeds the primary monitoring criterion for this analyte.

-- = Not analyzed for in background samples.

DUP = Field duplicate sample

J = Estimated value

µg/L = micrograms per liter

NA = Not available

NSB-NLON = Naval Submarine Base New London

SVOCs = Semivolatile organic compounds

U = Undetected value

Bold type denotes analyte detection.

Shaded boxes denote exceedances of primary or secondary monitoring criterion and/or background groundwater concentrations.

TABLE 3-2
GROUNDWATER ANALYTICAL RESULTS SUMMARY, ROUNDS 18 AND 19
YEAR 7 ANNUAL GROUNDWATER MONITORING REPORT
AREA A LANDFILL, NSB-NLON, GROTON, CONNECTICUT

Chemical	Primary Monitoring Criterion [1]	NSB-NLON Background Concentration[2]	2WMW44DS Round 18 8/24/2006	2WMW44DS Round 19 12/12/2006	2WMW46DS Round 18 8/30/2006	2WMW46DS Round 19 12/12/2006	2WMW46DS (DUP) Round 19 12/12/2006	2LOW1D Round 18 8/30/2006	2LOW1D Round 19 12/13/2006
SVOCs (µg/L)									
BENZO(A)ANTHRACENE	0.3	--	0.039 U	0.039 U	0.038 U	0.04 U	0.041 U	0.038 U	**0.16** J
BENZO(A)PYRENE	0.3	--	0.041 U	0.041 U	0.04 U	0.042 U	0.043 U	0.04 U	**0.16** J
BENZO(B)FLUORANTHENE	0.3	--	0.052 U	0.051 U	0.05 U	0.052 U	0.054 U	0.05 U	**0.18** J
BENZO(K)FLUORANTHENE	0.3	--	0.037 U	0.037 U	0.036 U	0.038 U	0.039 U	0.036 U	**0.14** J
BIS(2-ETHYLHEXYL)PHTHALATE	59	--	6.5 U	1.7 U	6.7 U	1.7 U	1.8 U	1.6 U	1.7 U
PHENANTHRENE	0.3	--	0.032 U	**0.032** J	0.031 U	0.032 U	0.033 U	0.031 U	**0.073** J
Inorganics (Total) (µg/L)									
ARSENIC	150	1.92	**6.3** J	**6.7**	**4.1** J	**21.7**	**22.6**	0.034 UJ	**1.6**
BERYLLIUM	4	NA	0.5 U	0.3 U	0.5 U	0.3 U	0.3 U	0.5 U	0.3 U
CADMIUM	0.25 [3]	NA	0.034 U	0.24 U	0.034 U	**0.4** J	0.17 UJ	0.034 U	**0.34** J
CHROMIUM	11	49.9	**4.6** J	**3.84** J	**9.5** J	**10.1**	**10.8**	0.28 UJ	**2.7**
COPPER	4.8	107	**4.9** J	**3.64** J	**10.5** J	**11**	**11.1**	**1** J	**17.6**
LEAD	1.2	6.63	**0.28** J	**0.49** J	**0.23** J	**0.65** J	**0.32** J	**0.53** J	**16.3**
ZINC	65	131	**20.6**	**47.7**	**27.7**	**73.8**	**74.5**	**4.95** J	**90.5**
Inorganics (Dissolved) (µg/L)									
ARSENIC	150	2.55	**1.9** J	**5**	**13.1** J	**12** J	**26** J	**1.1** J	**1**
BERYLLIUM	4	NA	0.1 UJ	0.3 U	0.1 UJ	0.3 U	0.3 U	0.1 UJ	0.3 U
CADMIUM	0.25 [3]	NA	0.034 U	0.034 U	0.034 U	0.034 U	0.034 U	**0.05** J	0.034 U
CHROMIUM	11	16	**1.9** J	**2**	**9** J	**9**	**9**	0.13 U	0.3 U
COPPER	4.8	39.4	**2** J	**2**	**16.2** J	**11**	**17**	**0.39** J	**0.5** J
LEAD	1.2	2.52	0.09 U	0.1 U	0.05 U	**0.3** J	0.2 UJ	0.1 U	**0.1** J
ZINC	65	109	**8.8** J	7 U	**30.3** J	**69**	**73**	**5.8** J	**11**

Notes:

(1) Based on Federal Ambient Water Quality Criteria for protection of aquatic life (chronic, freshwater) (USEPA, 1999) and Connecticut Water Quality Criteria for protection of human health from consumption of organisms (CTDEP, 1997).

(2) Total/Dissolved background concentration taken from Basewide Groundwater Remedial Investigation Report (TtNUS, January, 1996).

(3) The reporting limit from the laboratory exceeds the primary monitoring criterion for this analyte.

-- = Not analyzed for in background samples.

DUP = Field duplicate sample

J = Estimated value

µg/L = micrograms per liter

NA = Not available

NSB-NLON = Naval Submarine Base New London

SVOCs = Semivolatile organic compounds

U = Undetected value

Bold type denotes analyte detection.

Shaded boxes denote exceedances of primary or secondary monitoring criterion and/or background groundwater concentrations.

TABLE 3-2
GROUNDWATER ANALYTICAL RESULTS SUMMARY, ROUNDS 18 AND 19
YEAR 7 ANNUAL GROUNDWATER MONITORING REPORT
AREA A LANDFILL, NSB-NLON, GROTON, CONNECTICUT

Chemical	Primary Monitoring Criterion (1)	NSB-NLON Background Concentration(2)	3MW12D Round 18 8/29/2006	3MW12D Round 19 12/13/2006	3MW37S Round 18 8/29/2006	3MW37S Round 19 12/13/2006	4MW1S Round 18 8/25/2006	4MW1S Round 19 12/13/2006
SVOCs (µg/L)								
BENZO(A)ANTHRACENE	0.3	--	0.039 U	0.04 U	0.038 U	**0.063 J**	0.038 U	0.04 U
BENZO(A)PYRENE	0.3	--	0.041 U	0.042 U	0.04 U	0.042 U	0.04 U	0.042 U
BENZO(B)FLUORANTHENE	0.3	--	0.052 U	0.053 U	0.05 U	0.053 U	0.05 U	0.053 U
BENZO(K)FLUORANTHENE	0.3	--	0.037 U	0.038 U	0.036 U	0.038 U	0.036 U	0.038 U
BIS(2-ETHYLHEXYL)PHTHALATE	59	--	1.7 U	1.7 U	1.6 U	1.7 U	1.6 U	1.8 U
PHENANTHRENE	0.3	--	0.032 U	0.033 U	0.031 U	**0.039 J**	0.031 U	0.033 U
Inorganics (Total) (µg/L)								
ARSENIC	150	1.92	0.034 UJ	**1.3**	0.034 UJ	**0.8**	0.034 UJ	**0.18 J**
BERYLLIUM	4	NA	0.5 U	0.3 U	0.5 U	0.3 U	0.5 U	0.3 U
CADMIUM	0.25 (3)	NA	0.034 U	0.04 U	**0.08 J**	0.15 U	0.034 U	0.07 U
CHROMIUM	11	49.9	0.22 U	**0.34 J**	0.28 UJ	**0.76 J**	0.25 UJ	**0.28 J**
COPPER	4.8	107	**0.94 J**	**1.2**	**3 J**	**4.5**	**0.97 J**	**0.72 J**
LEAD	1.2	6.63	0.028 UJ	**0.32 J**	0.028 UJ	**0.52 J**	0.05 UJ	**0.67 J**
ZINC	65	131	**4.52 J**	**10.9**	**2.28 J**	**35.2**	**5.1**	6 U
Inorganics (Dissolved) (µg/L)								
ARSENIC	150	2.55	**0.69 J**	**1**	**0.28 J**	**0.9 J**	**0.06 J**	0.2 U
BERYLLIUM	4	NA	0.1 UJ	0.3 U	0.1 UJ	0.3 U	0.1 UJ	0.3 U
CADMIUM	0.25 (3)	NA	**0.04 J**	0.1 U	0.034 U	0.2 U	0.034 U	**0.1 J**
CHROMIUM	11	16	0.16 U	0.3 U	0.19 U	0.3 U	0.19 U	0.4 U
COPPER	4.8	39.4	**0.93 J**	**0.8 J**	**1.3 J**	**2**	**1.3 J**	**0.8 J**
LEAD	1.2	2.52	**0.24 J**	**0.1 J**	0.08 U	**0.1 J**	0.17 U	0.1 U
ZINC	65	109	4.65 UJ	7 U	3.18 UJ	**10**	4.42 U	5 U

Notes:

(1) Based on Federal Ambient Water Quality Criteria for protection of aquatic life (chronic, freshwater) (USEPA, 1999) and Connecticut Water Quality Criteria for protection of human health from consumption of organisms (CTDEP, 1997).

(2) Total/Dissolved background concentration taken from Basewide Groundwater Remedial Investigation Report (TtNUS, January, 1996).

(3) The reporting limit from the laboratory exceeds the primary monitoring criterion for this analyte.

-- = Not analyzed for in background samples.

DUP = Field duplicate sample

J = Estimated value

µg/L = micrograms per liter

NA = Not available

NSB-NLON = Naval Submarine Base New London

SVOCs = Semivolatile organic compounds

U = Undetected value

Bold type denotes analyte detection.

Shaded boxes denote exceedances of primary or secondary monitoring criterion and/or background groundwater concentrations.

ATTACHMENT A.5

RISKS BASED ON LASTEST ROUND

OF GROUNDWATER SAMPLING ANALYTICAL RESULTS

TABLE 4.1.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURES - QUARTERLY MONITORING

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	*Construction Workers*	Adult	Site 2	Daevent	Dermally Absorbed Dose per Event	Calculated	mg/cm2-event	U.S. EPA, 2004	Dermally Absorbed Dose (mg/kg/day) =
				SA	Skin Surface Available for Contact	3300	cm2	U.S. EPA, 2004	
				EV	Event Frequency	1	events/day	(1)	DAevent x EV x EF x ED x SA
				ET	Exposure Time	4	hours/day	(1)	BW x AT
				EF	Exposure Frequency	30	days/year	(1)	
				ED	Exposure Duration	1	years	(1)	See text for calculation of DAevent.
				BW	Body Weight	70	kg	U.S. EPA, 1989	
				AT-C	Averaging Time (Cancer)	25550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	365	days	U.S. EPA, 1989	

Sources:

1 - Professional judgment.

U.S. EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

Unit Intake Calculations

Ingestion Intake = (IR-GW x EF x ED)/(BW x AT)

Dermal Intake = (SA x EV x EF x ED)/(BW x AT)

Cancer Ingestion Intake = NA

Noncancer Ingestion Intake = NA

Cancer Dermal Intake = 5.54E-02

Noncancer Dermal Intake = 3.87E+00

TABLE 4.2.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURES - QUARTERLY MONITORING

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Construction Workers	Adult	Site 2	CA	Chemical concentration in air	Calculated	mg/m3	VDEQ, 2004	Intake (mg/kg/day) =
				CW	Chemical concentration in water.	Average	ug/L		
				CF	Conversion Factor	0.001	mg/ug	--	CA x IR x ET x EF x ED
				IR	Inhalation Rate	2.5	m3/hour	U.S. EPA, 1993	BW x AT
				ET	Exposure Time	4	hours/day	(1)	
				EF	Exposure Frequency	30	days/year	(1)	CA = CW x CF x VF
				ED	Exposure Duration	1	years	(1)	
				BW	Body Weight	70	kg	U.S. EPA, 1989	
				AT-C	Averaging Time (Cancer)	25550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	365	days	U.S. EPA, 1989	
				VF	Volatilization Factor	Calculated	(mg/m3)/(mg/L)	VDEQ, 2004	

Notes:

1 - Professional judgment.

U.S. EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

U.S. EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

VDEQ, 2004: Virginia Department of Environmental Quality (VDEQ, online- http://www.deq.state.va.us/vrprisk/homepage.html).

Unit Intake Calculations

Inhalation Intake = (IR x ET x EF x ED)/(BW x AT)

Cancer Inhalation Intake = 1.68E-04 Noncancer Inhalation Intake = 1.17E-02

TABLE 4.3.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURES - QUARTERLY MONITORING

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Residents	Child	Site 2	CGW	Chemical Concentration in Groundwater	Max or 95% UCL	mg/kg	U.S. EPA, 2002a	Chronic Daily Intake (CDI) (mg/kg/day) =
				CF	Conversion Factor	0.001	mg/ug	--	
				IR-GW	Ingestion Rate of Groundwater	1.5	L/day	U.S. EPA, 1994	CW x CF x IR-GW x EF x ED
				EF	Exposure Frequency	350	days/year	U.S. EPA, 1994	BW x AT
				ED1	Exposure Duration (Age 0 - 2)	2	years	U.S. EPA, 1989	
				ED2	Exposure Duration (Age 2 - 6)	4	years	U.S. EPA, 1989	
				BW	Body Weight	15	kg	U.S. EPA, 1991	
				AT-C	Averaging Time (Cancer)	25550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2190	days	U.S. EPA, 1989	
Dermal	Residents	Child	Site 2	Daevent	Dermally Absorbed Dose per Event	Calculated	mg/cm2-event	U.S. EPA, 2004	Dermally Absorbed Dose (mg/kg/day) =
				SA	Skin Surface Available for Contact	6,600	cm2	U.S. EPA, 2004	
				EV	Event Frequency	1	events/day	U.S. EPA, 2004	DAevent x EV x EF x ED x SA
				ET	Exposure Time	0.25	hours/day	U.S. EPA, 1997	BW x AT
				EF	Exposure Frequency	350	days/year	U.S. EPA, 1994	
				ED1	Exposure Duration (Age 0 - 2)	2	years	U.S. EPA, 1989	See text for calculation of DAevent.
				ED2	Exposure Duration (Age 2 - 6)	4	years	U.S. EPA, 1989	
				BW	Body Weight	15	kg	U.S. EPA, 1991	
				AT-C	Averaging Time (Cancer)	25550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2190	days	U.S. EPA, 1989	

Sources:

U.S. EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

U.S. EPA, 1991: Risk Assessment Guidance for Superfund - Supplemental Guidance- Standard Default Exposure Factors Interim Final.

U.S. EPA, 1994: U.S. EPA Region I Risk Updates, August 1994.

U.S. EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa

U.S. EPA, 2002:Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. OSWER 9285.6-10, December.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

Unit Intake Calculations

Ingestion Intake = (IR-GW x EF x ED)/(BW x AT)

Dermal Intake = (SA x EV x EF x ED)/(BW x AT)

Cancer Ingestion Intake (Age 0 - 2) = 2.74E-06

Cancer Ingestion Intake (Age 2 - 6) = 5.48E-06

Cancer Dermal Intake (Age 0 - 2) = 1.21E+01

Cancer Dermal Intake (Age 2 - 6) = 2.41E+01

Noncancer Ingestion Intake = 9.59E-05

Noncancer Dermal Intake = 4.22E+02

TABLE 4.4.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURES - QUARTERLY MONITORING

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Residents	Adult	Site 2	CGW	Chemical Concentration in Groundwater	95% UCL or Max	ug/L	U.S. EPA, 2002	Chronic Daily Intake (CDI) (mg/kg/day) =
				CF	Conversion Factor	0.001	mg/ug	--	
				IR-GW	Ingestion Rate of Groundwater	2	L/day	U.S. EPA, 1994	CW x CF x IR-GW x EF x ED
				EF	Exposure Frequency	350	days/year	U.S. EPA, 1994	BW x AT
				ED1	Exposure Duration (Age 10 - 16)	10	years	U.S. EPA, 1989	
				ED2	Exposure Duration (Age 16 - 30)	14	years	U.S. EPA, 1989	
				BW	Body Weight	70	kg	U.S. EPA, 1989	
				AT-C	Averaging Time (Cancer)	25,550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,650	days	U.S. EPA, 1989	
Dermal	Residents	Adult	Site 2	Daevent	Dermally Absorbed Dose per Event	Calculated	mg/cm2-event	U.S. EPA, 2004	Dermally Absorbed Dose (mg/kg/day) =
				SA	Skin Surface Available for Contact	18,000	cm2	U.S. EPA, 2004	
				EV	Event Frequency	1	events/day	U.S. EPA, 2004	DAevent x EV x EF x ED x SA
				ET	Exposure Time	0.25	hours/day	U.S. EPA, 2004	BW x AT
				EF	Exposure Frequency	350	days/year	U.S. EPA, 1994	
				ED1	Exposure Duration (Age 10 - 16)	10	years	U.S. EPA, 1989	See text for calculation of DAevent.
				ED2	Exposure Duration (Age 16 - 30)	14	years	U.S. EPA, 1989	
				BW	Body Weight	70	kg	U.S. EPA, 1989	
				AT-C	Averaging Time (Cancer)	25,550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,650	days	U.S. EPA, 1989	

Sources:

U.S. EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

U.S. EPA, 1991: Risk Assessment Guidance for Superfund - Supplemental Guidance- Standard Default Exposure Factors Interim Final.

U.S. EPA, 1994: U.S. EPA Region I Risk Updates, August 1994.

U.S. EPA, 1997: Exposure Factors Handbook. U.S. EPA/600/8-95/002FA.

U.S. EPA, 2002: Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. OSWER 9285.6-10.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

Unit Intake Calculations

Ingestion Intake = (IR-GW x EF x ED)/(BW x AT)

Dermal Intake = (SA x EV x EF x ED)/(BW x AT)

Cancer Ingestion Intake Age 10 - 16) = 3.91E-06

Cancer Ingestion Intake Age 16 - 30) = 5.48E-06

Cancer Dermal Intake Age 10 - 16) = 3.52E+01

Cancer Dermal Intake (Age 16 - 30) = 4.93E+01

Noncancer Ingestion Intake = 6.58E-05

Noncancer Dermal Intake = 5.92E+02

TABLE 4.5
INTERMEDIATE VARIABLES FOR CALCULATING DA(EVENT)
SITE 2 - QUARTERLY MONITORING
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Media	Dermal Absorption Fraction (soil)	FA	Kp		T(event)		Tau		T*		B
			Value	Value	Units	Value	Units	Value	Units	Value	Units	Value
Volatile Organic Compounds												
Trichloroethene	Groundwater	NA	1	1.2E-02	cm/hr	(1)	hr	5.8E-01	hr	1.4E+00	hr	5.1E-02
Semivolatile Organic Compounds												
Benzo(a)anthracene(2)	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene(2)	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene(2)	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene(2)	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene(2)	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Inorganics												
Arsenic	Groundwater	NA	1	1.0E-03	cm/hr	(1)	hr	NA	NA	NA	NA	NA
Cadmium	Groundwater	NA	1	1.0E-03	cm/hr	(1)	hr	NA	NA	NA	NA	NA
Chromium	Groundwater	NA	1	2.0E-03	cm/hr	(1)	hr					
Copper	Groundwater	NA	1	1.0E-03	cm/hr	(1)	hr	NA	NA	NA	NA	NA
Zinc	Groundwater	NA	1	6.0E-04	cm/hr	(1)	hr	NA	NA	NA	NA	NA

Notes:
All values from EPA's Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final, July 2004.
1 - T_{event} is 4 hours for the construction worker and 0.25 hours for the child and adult resident.
2 - RAGS Part E recommends that dermal exposures to PAHs in water should not be quantitatively evaluated in the risk assessment.
FA = Fraction Absorbed Water
Kp = Dermal Permeability Coefficient of Compound in Water
T(event) = Event Duration
Tau = Lag Time
T* = Time to Reach Steady-State
B = Dimensionless Ratio of the Permeability Coefficient of a Compound Through the Stratum Corneum Relative to its Permeability Coefficient Across the Viable Epidermis
NA = Not applicable.

TABLE 5.1
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
SITE 2 - PHASE II RI RE-EVALUATION
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal (1)	Absorbed RfD for Dermal (2)		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD:Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Semivolatile Organic Compounds										
Bis(2-ethylhexyl)phthalate	Chronic	2.0E-02	mg/kg/day	1	2.0E-02	mg/kg/day	Liver	1000/1	IRIS	4/23/2008
Inorganics										
Antimony	Chronic	4.0E-04	mg/kg/day	0.15	6.0E-05	mg/kg/day	Blood	1000/1	IRIS	4/23/2008
Arsenic	Chronic	3.0E-04	mg/kg/day	1	3.0E-04	mg/kg/day	Skin, CVS	3/1	IRIS	4/23/2008
Barium	Chronic	2.0E-01	mg/kg/day	0.07	1.4E-02	mg/kg/day	Kidney	300/1	IRIS	4/23/2008
Beryllium	Chronic	2.0E-03	mg/kg/day	0.007	1.4E-05	mg/kg/day	GS	300/1	IRIS	4/23/2008
Boron	Chronic	2.0E-01	mg/kg/day	1	2.0E-01	mg/kg/day	Developmental	66/1	IRIS	4/23/2008
Cadmium	Chronic	5.0E-04	mg/kg/day	0.05	2.5E-05	mg/kg/day	Kidney	10/1	IRIS	4/23/2008
Manganese	Chronic	2.4E-02	mg/kg/day	0.04	9.6E-04	mg/kg/day	CNS	1/3	IRIS	4/23/2008
Nickel	Chronic	2.0E-02	mg/kg/day	0.04	8.0E-04	mg/kg/day	Body Weight	300/1	IRIS	4/23/2008
Thallium (3)	Chronic	7.0E-05	mg/kg/day	1	7.0E-05	mg/kg/day	Liver	3000	USEPA III	10/11/2007
Vanadium	Chronic	1.0E-03	mg/kg/day	0.026	2.6E-05	mg/kg/day	Kidney	300	USEPA III	10/11/2007

Notes:
1 - U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.
2 - Adjusted dermal RfD = Oral RfD x Oral Absorption Efficiency for Dermal.
3 - Weight adjustment of the IRIS value.

Definitions:
CNS = Central Nervous System
CVS = Cardiovascular system
USEPA III = U.S. EPA Region 3 RBC Table, October 11, 2007.
GS = Gastrointestinal system
IRIS = Integrated Risk Information System
NA = Not Applicable

TABLE 5.2
NON-CANCER TOXICITY DATA -- INHALATION
SITE 2 - PHASE II RI RE-EVALUATION
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Extrapolated RfD(1)		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfC : Target Organ(s)	
		Value	Units	Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Volatile Organic Compounds									
Trichloroethene	Chronic	3.5E-02	mg/m3	1.0E-02	(mg/kg/day)	Liver, CNS	NA	USEPA(1)	8/2001
Semivolatile Organic Compounds									
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Inorganics									
Arsenic	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barium	Chronic	5.0E-04	mg/m3	1.4E-04	(mg/kg/day)	Fetotoxicity	1000	HEAST	7/97
Cadmium	Chronic	2.0E-04	mg/m3	5.8E-05	(mg/kg/day)	Kidney	NA	USEPA III	10/11/2007
Chromium	Chronic	1.0E-04	mg/m^3	2.9E-05	(mg/kg/day)	Lungs	300/1	IRIS	4/23/2008
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
1 - Extrapolated RfD = RfC *$20m^3$/day / 70 kg

Definitions:
CNS = Central Nervous System
USEPA III = U.S. EPA Region 3 RBC Table, October 11, 2007.
GS = Gastrointestinal
HEAST= Health Effects Assessment Summary Tables
IRIS = Integrated Risk Information System
NA = Not Applicable

TABLE 6.1
CANCER TOXICITY DATA -- ORAL/DERMAL
SITE 2 - PHASE II RI RE-EVALUATION
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal(1)	Absorbed Cancer Slope Factor for Dermal(2)		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units		Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Semivolatile Organic Compounds								
Bis(2-ethylhexyl)phthalate	1.4E-02	$(mg/kg/day)^{-1}$	1	1.4E-02	$(mg/kg/day)^{-1}$	B2	IRIS	4/23/2008
Inorganics								
Antimony	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	1.5E+00	$(mg/kg/day)^{-1}$	1	1.5E+00	$(mg/kg/day)^{-1}$	A	IRIS	4/23/2008
Barium	NA	NA	NA	NA	NA	D	IRIS	4/23/2008
Beryllium	NA	NA	NA	NA	NA	B1	IRIS	4/23/2008
Boron	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	B1	IRIS	4/23/2008
Manganese	NA	NA	NA	NA	NA	D	IRIS	4/23/2008
Nickel	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
1 - U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.
2 - Adjusted cancer slope factor for dermal = Oral cancer slope factor / Oral Absorption Efficiency for Dermal.

IRIS = Integrated Risk Information System.
NA = Not Available.

EPA Group:
A - Human carcinogen.
B1 - Probable human carcinogen - indicates that limited human data are available.
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans .
C - Possible human carcinogen.
D - Not classifiable as a human carcinogen.
E - Evidence of noncarcinogenicity.

TABLE 6.2
CANCER TOXICITY DATA -- INHALATION
SITE 2 - PHASE II RI RE-EVALUATION
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Unit Risk		Inhalation Cancer Slope Factor[1]		Weight of Evidence/ Cancer Guideline Description	Unit Risk : Inhalation CSF	
	Value	Units	Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Volatile Organic Compounds							
Trichloroethene	1.1E-04	(ug/m3)-1	4.0E-01	(mg/kg/day)-1	C	USEPA(1)	8/2001
Semivolatile Organic Compounds							
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	8.9E-04	$(ug/m^3)^{-1}$	3.1E+00	$(mg/kg/day)^{-1}$	NA	USEPA III	10/11/2007
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA	NA
Inorganics							
Arsenic	4.3E-03	$(ug/m^3)^{-1}$	1.5E+01	$(mg/kg/day)^{-1}$	A	IRIS	4/23/2008
Barium	NA	NA	NA	NA	D	IRIS	4/23/2008
Cadmium	1.8E-03	$(ug/m^3)^{-1}$	6.3E+00	$(mg/kg/day)^{-1}$	B1	IRIS	4/23/2008
Chromium	1.2E-02	$(ug/m^3)^{-1}$	4.2E+01	$(mg/kg/day)^{-1}$	A	IRIS	4/23/2008
Copper	NA	NA	NA	NA	D	IRIS	4/23/2008
Zinc	NA	NA	NA	NA	D	IRIS	4/23/2008

Notes:
1 - Inhalation CSF = Unit Risk * 70 kg / $20m^3$/day.

Definitions:
IRIS = Integrated Risk Information System.
NA = Not Available.
USEPA III = U.S. EPA Region 3 RBC Table, October 11, 2007.
USEPA(1) = Draft Trichloroethylene Health Risk Assessment: Synthesis and Characterization, August 2001.

EPA Group:
A - Human carcinogen.
B1 - Probable human carcinogen - indicates that limited human data are available.
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans .
C - Possible human carcinogen.
D - Not classifiable as a human carcinogen.
E - Evidence of noncarcinogenicity.

TABLE 7.1.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURES - QUARTERLY MONITORING
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: *Future*
Receptor Population: Construction Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Site 2	Dermal	Trichloroethene	1.00	ug/L	3.2E-09	(mg/kg/day)	4.0E-01	(mg/kg/day)$^{-1}$	1.3E-09	2.3E-07	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.0008
				Benzo(a)anthracene	0.160	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)pyrene	0.160	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.180	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	0.140	ug/L	0.0E+00	(mg/kg/day)	7.3E-02	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Phenanthrene	0.073	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	3.0E-02	(mg/kg/day)	--
				Arsenic	25.3	ug/L	5.6E-09	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	8.4E-09	3.9E-07	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.001
				Cadmium	0.400	ug/L	8.9E-11	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	6.2E-09	(mg/kg/day)	2.5E-05	(mg/kg/day)	0.0002
				Chromium	9.50	ug/L	4.2E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.9E-07	(mg/kg/day)	7.5E-05	(mg/kg/day)	0.004
				Copper	30.8	ug/L	6.8E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	4.8E-07	(mg/kg/day)	4.0E-02	(mg/kg/day)	0.00001
				Zinc	90.5	ug/L	1.2E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	8.4E-07	(mg/kg/day)	3.0E-01	(mg/kg/day)	0.000003
			Exp. Route Total								9.7E-09					0.006
		Exposure Point Total									9.7E-09					0.006
	Exposure Medium Total										9.7E-09					0.006
	Air	Site 2	Inhalation	Trichloroethene	3.2E-5	mg/m3	5.4E-09	(mg/kg/day)	4.0E-01	(mg/kg/day)$^{-1}$	2.2E-09	3.8E-07	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.00004
				Benzo(a)anthracene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)pyrene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	3.1E+00	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Phenanthrene	1.9E-6	mg/m3	3.2E-10	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.3E-08	(mg/kg/day)	NA	(mg/kg/day)	--
				Arsenic	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	1.5E+01	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Cadmium	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	6.3E+00	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	5.7E-05	(mg/kg/day)	--
				Chromium	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	2.9E-05	(mg/kg/day)	--
				Copper	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Zinc	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
			Exp. Route Total								2.2E-09					0.00004
		Exposure Point Total									2.2E-09					0.00004
	Exposure Medium Total										2.2E-09					0.00004
Medium Total											1.2E-08					0.006
										Total of Receptor Risks Across All Media	1.2E-08				Total of Receptor Hazards Across All Media	0.006

TABLE 7.2.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURES - QUARTERLY MONITORING
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Site 2	Ingestion	Trichloroethene	1.000	ug/L	8.2E-06	(mg/kg/day)	4.0E-01	(mg/kg/day)$^{-1}$	3.3E-06	9.6E-05	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.3
				Benzo(a)anthracene	0.160	ug/L	7.0E-06	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	5.1E-06	1.5E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)pyrene	0.160	ug/L	7.0E-06	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	5.1E-05	1.5E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.180	ug/L	7.9E-06	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	5.8E-06	1.7E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	0.140	ug/L	6.1E-06	(mg/kg/day)	7.3E-02	(mg/kg/day)$^{-1}$	4.5E-07	1.3E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Phenanthrene	0.073	ug/L	6.0E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	7.0E-06	(mg/kg/day)	3.0E-02	(mg/kg/day)	0.0002
				Arsenic	25.300	ug/L	2.1E-04	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	3.1E-04	2.4E-03	(mg/kg/day)	3.0E-04	(mg/kg/day)	8.1
				Cadmium	0.400	ug/L	3.3E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.8E-05	(mg/kg/day)	5.0E-04	(mg/kg/day)	0.08
				Chromium	9.500	ug/L	7.8E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	9.1E-04	(mg/kg/day)	3.0E-03	(mg/kg/day)	0.3
				Copper	30.800	ug/L	2.5E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.0E-03	(mg/kg/day)	4.0E-02	(mg/kg/day)	0.07
				Zinc	90.500	ug/L	7.4E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	8.7E-03	(mg/kg/day)	3.0E-01	(mg/kg/day)	0.03
			Exp. Route Total								3.8E-04					8.9
			Dermal	Trichloroethene	1.000	ug/L	1.5E-07	(mg/kg/day)	4.0E-01	(mg/kg/day)$^{-1}$	5.9E-08	5.2E-06	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.02
				Benzo(a)anthracene	0.160	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)pyrene	0.160	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.180	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	0.140	ug/L	0.0E+00	(mg/kg/day)	7.3E-02	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Phenanthrene	0.073	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	3.0E-02	(mg/kg/day)	--
				Arsenic	25.300	ug/L	7.6E-08	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	1.1E-07	2.7E-06	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.009
				Cadmium	0.400	ug/L	1.2E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	4.2E-08	(mg/kg/day)	2.5E-05	(mg/kg/day)	0.002
				Chromium	9.500	ug/L	5.7E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.0E-06	(mg/kg/day)	7.5E-05	(mg/kg/day)	0.03
				Copper	30.800	ug/L	9.3E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.2E-06	(mg/kg/day)	4.0E-02	(mg/kg/day)	0.00008
				Zinc	90.500	ug/L	1.6E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	5.7E-06	(mg/kg/day)	3.0E-01	(mg/kg/day)	0.00002
			Exp. Route Total								1.7E-07					0.05
		Exposure Point Total									3.8E-04					8.9
	Exposure Medium Total										3.8E-04					8.9
	Air	Site 2	Inhalation	Trichloroethene	1.000	ug/L	8.2E-06	(mg/kg/day)	4.0E-01	(mg/kg/day)$^{-1}$	3.3E-06	9.6E-05	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.3
				Benzo(a)anthracene	0.160	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)pyrene	0.160	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.180	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	0.140	ug/L	0.0E+00	(mg/kg/day)	7.3E-02	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Phenanthrene	0.073	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	3.0E-02	(mg/kg/day)	--
				Arsenic	25.300	ug/L	0.0E+00	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	3.0E-04	(mg/kg/day)	--
				Cadmium	0.400	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	5.0E-04	(mg/kg/day)	--
				Chromium	9.500	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	3.0E-03	(mg/kg/day)	--
				Copper	30.800	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	4.0E-02	(mg/kg/day)	--
				Zinc	90.500	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	3.0E-01	(mg/kg/day)	--
			Exp. Route Total								3.3E-06					0.3
		Exposure Point Total									3.3E-06					0.3
	Exposure Medium Total										3.3E-06					0.3
Medium Total											3.8E-04					9.3
										Total of Receptor Risks Across All Media	3.8E-04				Total of Receptor Hazards Across All Media	9.3

Note:
Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.

TABLE 7.3.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURES - QUARTERLY MONITORING
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Site 2	Ingestion	Trichloroethene	1.000	ug/L	7.8E-06	(mg/kg/day)	4.0E-01	$(mg/kg/day)^{-1}$	3.1E-06	6.6E-05	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.2
				Benzo(a)anthracene	0.160	ug/L	2.5E-06	(mg/kg/day)	7.3E-01	$(mg/kg/day)^{-1}$	1.8E-06	1.1E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)pyrene	0.160	ug/L	2.5E-06	(mg/kg/day)	7.3E+00	$(mg/kg/day)^{-1}$	1.8E-05	1.1E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.180	ug/L	2.8E-06	(mg/kg/day)	7.3E-01	$(mg/kg/day)^{-1}$	2.1E-06	1.2E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	0.140	ug/L	2.2E-06	(mg/kg/day)	7.3E-02	$(mg/kg/day)^{-1}$	1.6E-07	9.2E-06	(mg/kg/day)	NA	(mg/kg/day)	--
				Phenanthrene	0.073	ug/L	5.7E-07	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	4.8E-06	(mg/kg/day)	3.0E-02	(mg/kg/day)	--
				Arsenic	25.300	ug/L	2.0E-04	(mg/kg/day)	1.5E+00	$(mg/kg/day)^{-1}$	3.0E-04	1.7E-03	(mg/kg/day)	3.0E-04	(mg/kg/day)	5.5
				Cadmium	0.400	ug/L	3.1E-06	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	2.6E-05	(mg/kg/day)	5.0E-04	(mg/kg/day)	0.05
				Chromium	9.500	ug/L	7.4E-05	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	6.2E-04	(mg/kg/day)	3.0E-03	(mg/kg/day)	0.2
				Copper	30.800	ug/L	2.4E-04	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	2.0E-03	(mg/kg/day)	4.0E-02	(mg/kg/day)	0.05
				Zinc	90.500	ug/L	7.1E-04	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	6.0E-03	(mg/kg/day)	3.0E-01	(mg/kg/day)	0.02
			Exp. Route Total								3.2E-04					6.1
			Dermal	Trichloroethene	1.000	ug/L	1.0E-06	(mg/kg/day)	4.0E-01	$(mg/kg/day)^{-1}$	4.1E-07	7.3E-06	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.02
				Benzo(a)anthracene	0.160	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)pyrene	0.160	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.180	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	0.140	ug/L	0.0E+00	(mg/kg/day)	7.3E-02	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Phenanthrene	0.073	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	3.0E-02	(mg/kg/day)	--
				Arsenic	25.300	ug/L	5.3E-07	(mg/kg/day)	1.5E+00	$(mg/kg/day)^{-1}$	8.0E-07	3.7E-06	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.01
				Cadmium	0.400	ug/L	8.5E-09	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	5.9E-08	(mg/kg/day)	2.5E-05	(mg/kg/day)	0.002
				Chromium	9.500	ug/L	4.0E-07	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	2.8E-06	(mg/kg/day)	7.5E-05	(mg/kg/day)	0.04
				Copper	30.800	ug/L	6.5E-07	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	4.6E-06	(mg/kg/day)	4.0E-02	(mg/kg/day)	0.0001
				Zinc	90.500	ug/L	1.1E-06	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	8.0E-06	(mg/kg/day)	3.0E-01	(mg/kg/day)	0.00003
			Exp. Route Total								1.2E-06					0.08
		Exposure Point Total									3.2E-04					6.2
	Exposure Medium Total										3.2E-04					6.2
	Air	Site 2	Inhalation	Trichloroethene	1.000	ug/L	7.8E-06	(mg/kg/day)	4.0E-01	$(mg/kg/day)^{-1}$	3.1E-06	6.6E-05	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.2
				Benzo(a)anthracene	0.160	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)pyrene	0.160	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.180	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	0.140	ug/L	0.0E+00	(mg/kg/day)	7.3E-02	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Phenanthrene	0.073	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	3.0E-02	(mg/kg/day)	--
				Arsenic	25.300	ug/L	0.0E+00	(mg/kg/day)	1.5E+00	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	3.0E-04	(mg/kg/day)	--
				Cadmium	0.400	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	5.0E-04	(mg/kg/day)	--
				Chromium	9.500	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	3.0E-03	(mg/kg/day)	--
				Copper	30.800	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	4.0E-02	(mg/kg/day)	--
				Zinc	90.500	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	3.0E-01	(mg/kg/day)	--
			Exp. Route Total								3.1E-06					0.2
		Exposure Point Total									3.1E-06					0.2
	Exposure Medium Total										3.1E-06					0.2
Medium Total											3.3E-04					6.4
									Total of Receptor Risks Across All Media		3.3E-04	Total of Receptor Hazards Across All Media				6.4

Note:
Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.

TABLE 9.1.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURES - QUARTERLY MONITORING

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Construction Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 2	Trichloroethene	--	–	1E-09	–	1E-09	Liver	–	--	0.0008	0.0008
			Benzo(a)anthracene	--	–	--	–	--	NA	–	--	–	–
			Benzo(a)pyrene	--	–	--	–	--	NA	–	--	–	–
			Benzo(b)fluoranthene	--	–	--	–	--	NA	–	--	–	–
			Benzo(k)fluoranthene	--	–	--	–	--	NA	–	--	–	–
			Phenanthrene	--	–	--	–	--	Kidney	–	--	–	–
			Arsenic	--	–	8E-09	–	8E-09	Skin, CVS	–	--	0.001	0.001
			Cadmium	--	–	--	–	--	Kidney	–	--	0.0002	0.0002
			Chromium	--	–	--	–	--	Fetotoxicity, GS, Bone	–	--	0.004	0.004
			Copper	--	–	--	–	--	GS	–	--	0.00001	0.00001
			Zinc	--	–	--	–	--	Blood	–	--	0.000003	0.000003
			Chemical Total	--	–	1E-08	–	1E-08		–	--	0.006	0.006
		Exposure Point Total						1E-08					0.006
	Exposure Medium Total							1E-08					0.006
	Groundwater	Site 2	Trichloroethene	–	2E-09	–	–	2E-09	NA	--	0.00004	--	0.00004
			Benzo(a)anthracene	–	--	–	–	--	NA	--	–	--	–
			Benzo(a)pyrene	–	--	–	–	--	NA	--	–	--	–
			Benzo(b)fluoranthene	–	--	–	–	--	NA	--	–	--	–
			Benzo(k)fluoranthene	–	--	–	–	--	NA	--	–	--	–
			Phenanthrene	–	--	–	–	--	NA	--	–	--	–
			Arsenic	–	--	–	–	--	NA	--	–	--	–
			Cadmium	–	--	–	–	--	Kidney	--	–	--	–
			Chromium	–	--	–	–	--	Lungs	--	–	--	–
			Copper	–	--	–	–	--	NA	--	–	--	–
			Zinc	–	--	–	–	--	NA	--	–	--	–
			Chemical Total	–	2E-09	–	–	2E-09		--	0.00004	--	0.00004
		Exposure Point Total						2E-09					0.00004
	Exposure Medium Total							2E-09					0.00004
Medium Total								1E-08					0.006
Receptor Total							Receptor Risk Total	1E-08				Receptor HI Total	0.006

Total Blood HI	0.000003
Total CVS HI	0.001
Total GS HI	0.004
Total Kidney HI	0.0002
Total Liver HI	0.0008
Total Skin HI	0.001
Total Fetotoxicity HI	0.004
Total Bone HI	0.004

TABLE 9.2.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURES - QUARTERLY MONITORING

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 2	Trichloroethene	3E-06	--	6E-08	--	3E-06	Liver	0.3	--	0.02	0.3
			Benzo(a)anthracene	5E-06	--	--	--	5E-06	NA	--	--	--	--
			Benzo(a)pyrene	5E-05	--	--	--	5E-05	NA	--	--	--	--
			Benzo(b)fluoranthene	6E-06	--	--	--	6E-06	NA	--	--	--	--
			Benzo(k)fluoranthene	4E-07	--	--	--	4E-07	NA	--	--	--	--
			Phenanthrene	--	--	--	--	--	Kidney	0.0002	--	--	0.0002
			Arsenic	3E-04	--	1E-07	--	3E-04	Skin, CVS	8	--	0.009	8
			Cadmium	--	--	--	--	--	Kidney	0.08	--	0.002	0.08
			Chromium	--	--	--	--	--	Fetotoxicity, GS, Bone	0.3	--	0.03	0.3
			Copper	--	--	--	--	--	GS	0.07	--	0.00008	0.07
			Zinc	--	--	--	--	--	Blood	0.03	--	0.00002	0.03
			Chemical Total	4E-04	--	2E-07	--	4E-04		9	--	0.05	9
		Exposure Point Total						4E-04					9
	Exposure Medium Total							4E-04					9
	Groundwater	Site 2	Trichloroethene	--	3E-06	--	--	3E-06	NA	--	0.3	--	0.3
			Benzo(a)anthracene	--	--	--	--	--	NA	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	--	NA	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	--	NA	--	--	--	--
			Benzo(k)fluoranthene	--	--	--	--	--	NA	--	--	--	--
			Phenanthrene	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	--	--	--	--	NA	--	--	--	--
			Cadmium	--	--	--	--	--	Kidney	--	--	--	--
			Chromium	--	--	--	--	--	Lungs	--	--	--	--
			Copper	--	--	--	--	--	NA	--	--	--	--
			Zinc	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	3E-06	--	--	3E-06		--	0.3	--	0.3
		Exposure Point Total						3E-06					0.3
	Exposure Medium Total							3E-06					0.3
Medium Total								4E-04					9
Receptor Total							Receptor Risk Total	4E-04				Receptor HI Total	9

Note:

Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.

Total CVS HI	8
Total GS HI	0.4
Total Kidney HI	0.1
Total Liver HI	0.3
Total Skin HI	8

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES - QUARTERLY MONITORING
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 2	Trichloroethene	3E-06	--	4E-07	--	4E-06	Liver	0.2	--	0.02	0.2
			Benzo(a)anthracene	2E-06	--	--	--	2E-06	NA	--	--	--	--
			Benzo(a)pyrene	2E-05	--	--	--	2E-05	NA	--	--	--	--
			Benzo(b)fluoranthene	2E-06	--	--	--	2E-06	NA	--	--	--	--
			Benzo(k)fluoranthene	2E-07	--	--	--	2E-07	NA	--	--	--	--
			Phenanthrene	--	--	--	--	--	Kidney	--	--	--	--
			Arsenic	3E-04	--	8E-07	--	3E-04	Skin, CVS	6	--	0.01	6
			Cadmium	--	--	--	--	--	Kidney	0.05	--	0.002	0.05
			Chromium	--	--	--	--	--	Fetotoxicity, GS, Bone	0.2	--	0.04	0.2
			Copper	--	--	--	--	--	GS	0.05	--	0.0001	0.05
			Zinc	--	--	--	--	--	Blood	0.02	--	0.00003	0.02
			Chemical Total	3E-04	--	1E-06	--	3E-04		6	--	0.08	6
		Exposure Point Total						3E-04					6
	Exposure Medium Total							3E-04					6
	Groundwater	Site 2	Trichloroethene	--	3E-06	--	--	3E-06	NA	--	0.2	--	0.2
			Benzo(a)anthracene	--	--	--	--	--	NA	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	--	NA	--	--	--	--
			Benzo(b)fluoranthene	--	--	--	--	--	NA	--	--	--	--
			Benzo(k)fluoranthene	--	--	--	--	--	NA	--	--	--	--
			Phenanthrene	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	--	--	--	--	NA	--	--	--	--
			Cadmium	--	--	--	--	--	Kidney	--	--	--	--
			Chromium	--	--	--	--	--	Lungs	--	--	--	--
			Copper	--	--	--	--	--	NA	--	--	--	--
			Zinc	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	3E-06	--	--	3E-06		--	0.2	--	0.2
		Exposure Point Total						3E-06					0.2
	Exposure Medium Total							3E-06					0.2
Medium Total								3E-04					6
Receptor Total							Receptor Risk Total	3E-04				Receptor HI Total	6

Note:

Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.

Total Body Weight HI	--
Total CNS HI	0.0
Total CVS HI	6
Total GS HI	0.3
Total Kidney HI	0.1
Total Liver HI	0.2
Total Skin HI	6

TABLE 9.3.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURES - QUARTERLY MONITORING

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Lifelong (Child and Adult)

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 2	Trichloroethene	6E-06	--	5E-07	--	7E-06					
			Benzo(a)anthracene	7E-06	--	--	--	7E-06					
			Benzo(a)pyrene	7E-05	--	--	--	7E-05					
			Benzo(b)fluoranthene	8E-06	--	--	--	8E-06					
			Benzo(k)fluoranthene	6E-07	--	--	--	6E-07					
			Phenanthrene	--	--	--	--	--					
			Arsenic	6E-04	--	9E-07	--	6E-04					
			Cadmium	--	--	--	--	--					
			Chromium	--	--	--	--	--					
			Copper	--	--	--	--	--					
			Zinc	--	--	--	--	--					
			Chemical Total	7E-04	--	1E-06	--	7E-04					
		Exposure Point Total						7E-04					
	Exposure Medium Total							7E-04					
	Groundwater	Site 2	Trichloroethene	--	6E-06	--	--	6E-06					
			Benzo(a)anthracene	--	--	--	--	--					
			Benzo(a)pyrene	--	--	--	--	--					
			Benzo(b)fluoranthene	--	--	--	--	--					
			Benzo(k)fluoranthene	--	--	--	--	--					
			Phenanthrene	--	--	--	--	--					
			Arsenic	--	--	--	--	--					
			Cadmium	--	--	--	--	--					
			Chromium	--	--	--	--	--					
			Copper	--	--	--	--	--					
			Zinc	--	--	--	--	--					
			Chemical Total	--	6E-06	--	--	6E-06					
		Exposure Point Total						6E-06					
	Exposure Medium Total							6E-06					
Medium Total								7E-04					
Receptor Total							Receptor Risk Total	7E-04					

Note:

Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.

E.2 HUMAN HEALTH RISK ASSOCIATED WITH SITE 23 GROUNDWATER

From: Bob Jupin, Tetra Tech Risk Assessment Specialist
To: Corey Rich, Tetra Tech Project Manager
Date: May 19, 2008

Regarding: Human Health Risks Associated with Site 23 Groundwater

Historical and current information pertaining to Site 23 groundwater were reviewed to determine if Site 23 groundwater poses a threat to human health and the environment. Historical information reviewed as part of this evaluation included the Basewide Groundwater Operable Unit Remedial Investigation Report (BGOURI) (Tetra Tech, 2002) and data collected as part of the storm sewer rehabilitation (FWEC, 2001). Current data reviewed as part of this evaluation included the first four quarters of the underdrain metering pit sampling collected through February, 2008.

There have been changes in United States Environmental Protection Agency (USEPA) and Connecticut Department of Environmental Protection (CTDEP) guidance since the BGOURI HHRA was prepared. The major changes in guidance include:

- USEPA Region 9 Preliminary Remedial Goals (2004)
- CTDEP Remediation Standard Regulations (RSRs) Volatilization Criteria (2003)
- Draft Guidance for Evaluating the Vapor Intrusion into Indoor Air (USEPA, 2002).
- Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final Guidance (USEPA, 2004).
- Guidelines for Carcinogen Risk Assessment (USEPA, 2005a).
- Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens (USEPA, 2005b).

The revised guidance was used in this evaluation.

Site Description

Figure 1-1 shows the general location of the Naval Submarine Base and Figure 1-2 shows the location of Site 23. No. 2 and No. 6 fuel oil and waste oil were previously stored in underground storage tanks (USTs) at Site 23 and each tank had an underdrain system that collected groundwater to control water levels and associated hydraulic pressure. The USTs were properly closed in place and the underdrain systems were kept to reduce groundwater levels in the area. Evidence of releases of petroleum products from the tanks, their associated piping, and possibly from other nearby sources was detected during previous investigations. Remedial actions were taken to address petroleum products detected in the soil. No significant groundwater contamination was detected; however, low-levels of petroleum hydrocarbons were infrequently detected at the outfall of the storm sewer system near Goss Cove. Subsequently, the storm sewer at Site 23 was rehabilitated in 2000 such that the original combined groundwater and stormwater system was separated into a deep groundwater and a new shallow stormwater system (FWEC, 2001). Over 2,000 feet of the existing underdrain piping was relined with cured-in-place plastic pipe and a manhole was converted into a metering pit to measure groundwater flow volume.

Current and expected future site usage is industrial/commercial. Groundwater at Site 23 is classified GB. Groundwater at Site 23 is not used as a potable water source. Currently there are no direct contact exposures to groundwater. Potential receptors evaluated in the human health risk assessments for Site 23 included construction workers and hypothetical future residents.

Basewide Groundwater Operable Unit Remedial Investigation Report

Groundwater at Site 23 was evaluated in the BGOURI (Tetra Tech, 2002). As part of the evaluation concentrations of chemicals in groundwater were compare to USEPA and CTDEP screening criteria for direct contact (USEPA Region IX Preliminary Remedial Goals, USEPA Maximum Contaminant Levels, CTDEP Maximum Contaminant Levels, and CTDEP RSRs) and migration (CTDEP volatilization and surface water protection criteria). A copy of the comparisons is included in Attachment A.1. Maximum concentrations of tetrachloroethene, naphthalene, and lead exceeded the direct contact criteria (Table 13-4). Arsenic and lead were detected at concentrations exceeding the surface water protection criteria (Table 13-5). The human health risk assessment (HHRA) evaluated potential risks from exposures to groundwater by construction workers and hypothetical residents. The HHRA determined that risks for construction workers were less than USEPA and CTDEP acceptable levels (Table 13-6). Risk for future residents were within USEPA and CTDEP acceptable levels. However, the chemical specific cancer risk for tetrachloroethene exceeded the CTDEP target level of 1×10^{-6} for individual chemicals, although the maximum detected concentration of tetrachloroethene was less than its CTDEP RSR. The HHRA guidance has been updated since the BGOURI was prepared, but the changes in the HHRA guidance would not change the conclusions of the HHRA.

Storm Sewer Rehabilitation

The storm sewer system at Site 23 was rehabilitated in 2000 (FWEC, 2001). After completion of the storm sewer system, groundwater collected from the deep dewatering system around the closed underground storage tanks is conveyed to a metering pit within the Tank Farm. The metering pit is connected to the shallow stormwater system and the water is conveyed to the Thames River. Seven groundwater samples were collected from the metering pit between July 25, 2000 and May 23, 2001. A summary of the sample analytical results are included in Table 1 in Attachment A.2. it should be noted that this data was not validated. Table 1 includes a comparison of the data to CTDEP RSRs for surface water protection and volatilization. Concentrations of all chemicals in all seven groundwater samples were less than the volatilization criteria. Concentrations of total zinc exceeded the surface water protection criteria in samples collected in August and October, 2000. Concentrations of total lead exceeded the surface water protection criteria in samples collected in August 2000, October 2000, January 2001, April 2001, and May 2001. Concentrations of total arsenic exceeded the surface water protection criteria in samples collected in August 2000, October 2000, March 2001, April 2001, and May 2001, although total arsenic was also detected in the blank samples collected in 2001, indicating a potential laboratory blank contamination issue. Concentrations of all inorganics in filtered samples were less than the surface water protection criteria in all samples, suggesting that the elevated total arsenic and lead results were related to suspended soils in the samples. In general, concentrations of inorganics were highest in samples collected in August and October of 2000 shortly after completion of construction of the new storm water system and decreased significantly in subsequent sampling rounds. Concentrations of phenanthrene exceeded the surface water protection criteria in the samples collected in January 2001 and May 2001. Concentrations of benzo(b)fluoranthene, and benzo(k)fluoranthene exceeded the surface water protection criteria in the sample collected in May 2001. Considering the new risk methodology risks for construction workers exposed to groundwater would be within USEPA and CTDEP acceptable levels using the last round of sampling results (May 2001) (Attachment A.3).

Quarterly Underdrain Metering Pit Sampling

Four quarters of water samples were collected from the metering pit (Tetra Tech, 2008), which began in June 2007. The results of the sampling are presented in Table 3-1 in Attachment A.4. Included in Table 3-1 is a comparison to CTDEP RSRs for surface water protection and volatilization. None of the detected concentrations in the samples exceeded CTDEP volatilization criteria. In the sample collected in September 2007, the concentration of total arsenic exceeded the surface water protection criteria. However, the concentration of arsenic in the filtered sample was below the surface water protection criteria. In general concentrations of inorganics in the filtered samples were significantly less than the concentrations detected in the unfiltered samples. Also the sample log sheet indicates that orange precipitate was observed in the sample. Therefore, it is likely that the arsenic detected in the unfiltered sample was a result of suspended solid particles in the water and is not indicative of groundwater quality. Arsenic was not detected in the sample collected in December 2007 and was detected at a concentration below the surface water protection criteria in the sample collected in February 2008. In December 2007, concentrations of acenaphthylene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, hexachlorobenzene, and phenanthrene exceeded the surface water protection criteria. These chemicals were not detected in the duplicate sample collected in December 2007 and these chemicals were not detected in the sample collected in February 2008.

Table 2.1 in Attachment A.5 presents a comparison of the sampling results to human health screening criteria consisting of USEPA Region IX Preliminary Remediation Goals (PRGs) for tap water, USEPA Maximum Contaminant Levels (MCLs), CTDEP RSRs, and Connecticut MCLs. Several VOCs, SVOCs, and inorganics were detected at concentrations exceeding the human health screening criteria. Attachment A.5 also presents the results of a human health risk assessment (HHRA) for construction workers and hypothetical residents exposed to groundwater from the underdrain metering pit. Risks for construction workers exposed to groundwater are within USEPA and CTDEP acceptable levels. Cancer risks and hazard indices for hypothetical residents exceed USEPA and CTDEP acceptable levels, although Site 23 is not suitable for residential development. Hexachlorobenzene, carcinogenic PAHs, and arsenic were the major contributors to the cancer risks. Arsenic, iron, and manganese are the major contributors to the hazard indices. As discussed above hexachlorobenzene and carcinogenic PAHs were only detected in the sample collected in December 2007. Concentrations of arsenic and iron were only elevated in the sample collected in September 2007. In addition, concentrations of arsenic and iron in the filtered sample were significantly lower than those in the unfiltered sample. Concentrations of manganese were within site background levels.

Vapor Intrusion Evaluation for Groundwater

Groundwater data from Site 23 were evaluated to determine if there were unacceptable risks associated with vapor intrusion into buildings (Tetra Tech, 2008). Concentrations of volatile organic compounds (VOCs) in groundwater were compared to screening criteria for vapor intrusion. The screening criteria were obtained from USEPA's *OSWER Draft Guidance for Evaluating the Vapor Intrusion into Indoor Air from Groundwater and Soils (Subsurface Vapor Intrusion Guidance), November 2002,* CTDEP's *Proposed Revisions - Connecticut's Remediation Standard Regulations Volatilization Criteria, March 2003,* and USEPA Region I (April 24, 2008). Concentrations of chloroform and trichloroethene at Site 23 exceeded the USEPA screening criterion. These chemicals were further evaluated using USEPA's Johnson and Ettinger Vapor Intrusion Model. Modeling results showed that cancer risks and hazard indices for residential and industrial scenarios were within USEPA and CTDEP acceptable levels at Site 23. Further evaluation against PRGs and ARARs showed that vapor intrusion is not an issue at Site 23. It was concluded that no further action was required for vapor intrusion issues at Site 23.

Conclusions

Historical and current information pertaining to Site 23 groundwater were reviewed to determine if Site 23 groundwater poses a threat to human health and the environment. The conclusions of this evaluation are the following:

- The HHRA performed during the BGOURI evaluated potential risks from exposures to groundwater by construction workers and hypothetical residents, although it is unlikely that direct contact exposures to Site 23 groundwater would occur based on current and expected future site use. Cumulative risks were less than or within USEPA and CTDEP acceptable levels. However, chemical-specific risks for tetrachloroethene exceeded the CTDEP target level for individual chemicals, although the maximum detected concentration of tetrachloroethene was less than its CTDEP RSR (5 µg/L). Concentrations of tetrachloroethene in Site 23 groundwater have decreased from 3 µg/L in the BGOURI to 0.4 J µg/L during the second quarter of the underdrain meter pit sampling. Chemical-specific risks associated with tetrachloroethene would now be less than the CTDEP target level for individual chemicals.
- The HHRA guidance has been revised since the BGOURI HHRA was prepared but the changes in the guidance would not change the conclusions of the HHRA.
- Concentrations of chemicals in groundwater samples collected after the storm sewer rehabilitation were highest in samples collected in August and October, 2000 right after completion of construction and decreased significantly in subsequent sampling rounds.
- Concentrations of all chemicals detected in groundwater collected during the four quarters of the underdrain metering pit sampling were less than that CTDEP surface water protection and volatilization criteria with the exception of arsenic and several SVOCs. The concentration of total arsenic in the sample collected in September 2007 exceeded the surface water protection criteria although the concentration of arsenic in the filtered sample was less than the surface water protection criteria. The arsenic detected in the unfiltered sample is believed to be a result of suspended solid particles in the water and the filtered sample is more indicative of groundwater quality. Concentrations of acenaphthylene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, hexachlorobenzene, and phenanthrene exceeded the surface water protection criteria. These chemicals were not detected in the duplicate sample collected in December 2007 and these chemicals were not detected in the sample collected in February 2008.
- In general, concentrations of chemicals in Site 23 groundwater have decreased over time except as noted above.
- Potential risks for construction workers exposed to Site 23 groundwater are still acceptable using the analytical results from the four rounds of groundwater sampling. Potential risks for hypothetical residents exposed to Site 23 groundwater exceed acceptable levels, although Site 23 is not suitable for residential development.
- The vapor intrusion evaluation for groundwater determined that risks from vapor intrusion were with USEPA and CTDEP acceptable levels for residential and industrial scenarios. The evaluation concluded that no further action was required for vapor intrusion issues at Site 23.

- Based on existing information, under current and expected land use, Site 23 groundwater does not pose a significant threat to human health or the environment. Adverse health effects are possible under hypothetical residential land use.

References

CTDEP (Connecticut Department of Environmental Protection), 2003. Proposed Revision, Connecticut's Remediation Standard Regulations, Volatilization Criteria. Bureau of Water Management, Permitting, Enforcement and Remediation Division, Hartford. Connecticut. March.

FWEC (Foster Wheeler Environmental Corporation), 2001. Final Closeout Report for Storm Sewer Rehabilitation, Naval Submarine Base New London, Groton, Connecticut, Langhorne, Pennsylvania. May.

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Tetra Tech, 2007. Letter Report for September 2007 Sampling Event, Site 23 Underdrain Metering, Naval Submarine Base – New London, Groton, Connecticut. Pittsburgh, Pennsylvania, October.

Tetra Tech, 2008. Vapor Intrusion Evaluation for Groundwater at Operable Unit (OU) 9, Naval Submarine Base – New London, Groton, Connecticut. Pittsburgh, Pennsylvania. May 14.

USEPA (United States Environmental Protection Agency), 2002. Draft Guidance for Evaluating the Vapor Intrusion into Indoor Air. Office of Solid Waste and Emergency Response. EPA 530-F-02-052. November.

USEPA, 2004. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, (Part E, Supplemental Guidance for Dermal Risk Assessment). EPA/540/R/99/005, Office of Emergency and Remedial Response, Washington, D.C., July.

USEPA Region 9, 2004. Preliminary Remediation Goals, November.

USEPA, 2005a. Guidelines for Carcinogen Risk Assessment. EPA/630/P-03/001B. Risk Assessment Forum, Washington, DC. March.

USEPA, 2005b. Supplemental Guidance of Assessing Susceptibility from Early-Life Exposure to Carcinogens. EPA/630/R-03/003F. Risk Assessment Forum, Washington, DC. March.

USEPA Region I, 2008. EPA Comments on the Basewide Groundwater Vapor Intrusion Analyses. Email from Kymberlee Kecker of USEPA Region I to Corey Rich of Tetra Tech NUS, Inc. April 24.

FIGURES

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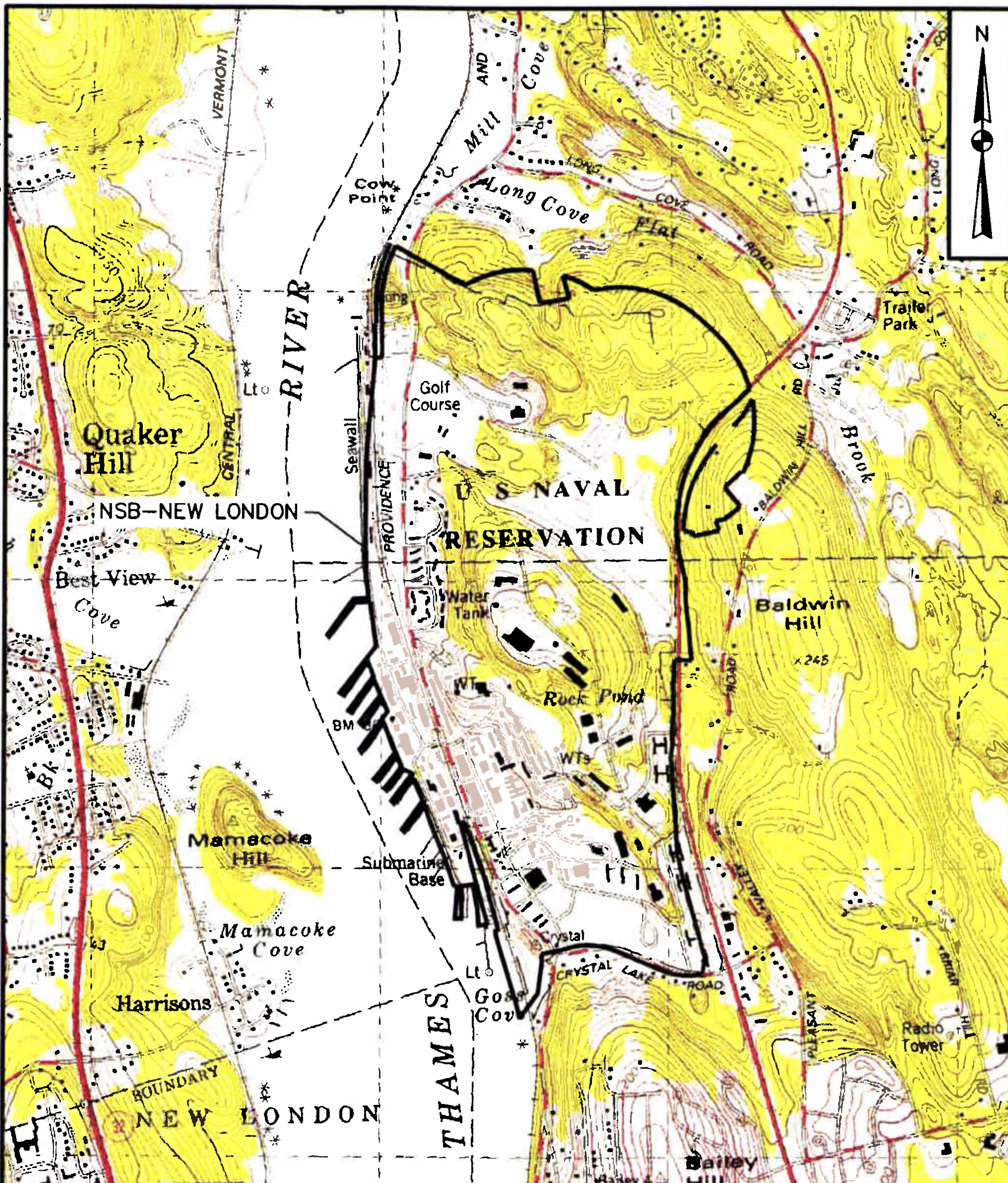
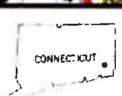




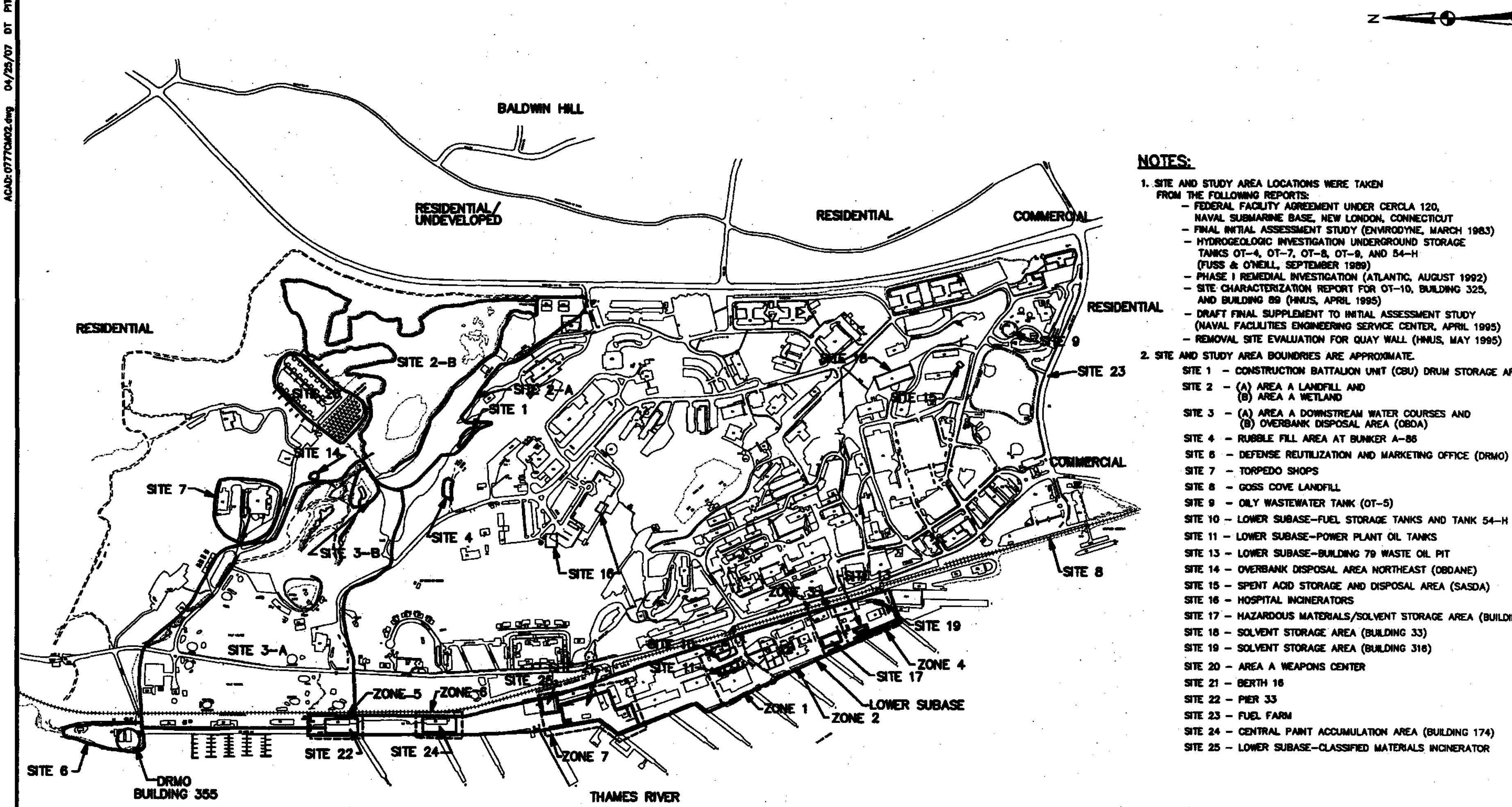
0 2000 4000
GRAPHIC SCALE IN FEET

SOURCE: USGS QUADRANGLE MAP UNCASVILLE, CONNECTICUT, 1984

DRAWN BY DT — DATE 4/25/07 CHECKED BY NJB — DATE 4/27/07 REVISED BY — DATE SCALE AS NOTED	Tetra Tech NUS, Inc.	FACILITY LOCATION MAP NSB-NLON GROTON, CONNECTICUT	CONTRACT NO. 0777 OWNER NO. 073 APPROVED BY CAR — DATE 4/27/07 DRAWING NO. FIGURE 1-1 — REV. 0

FORM CADD NO. TTNUS-AV.DWG - REV 1 -9/10/98

ACAD: 0777CM02.dwg 04/25/07 DT PIT



NOTES:

1. SITE AND STUDY AREA LOCATIONS WERE TAKEN FROM THE FOLLOWING REPORTS:
   - FEDERAL FACILITY AGREEMENT UNDER CERCLA 120, NAVAL SUBMARINE BASE, NEW LONDON, CONNECTICUT
   - FINAL INITIAL ASSESSMENT STUDY (ENVIRODYNE, MARCH 1983)
   - HYDROGEOLOGIC INVESTIGATION UNDERGROUND STORAGE TANKS OT-4, OT-7, OT-8, OT-9, AND 54-H (FUSS & O'NEILL, SEPTEMBER 1989)
   - PHASE I REMEDIAL INVESTIGATION (ATLANTIC, AUGUST 1992)
   - SITE CHARACTERIZATION REPORT FOR OT-10, BUILDING 325, AND BUILDING 89 (HNUS, APRIL 1995)
   - DRAFT FINAL SUPPLEMENT TO INITIAL ASSESSMENT STUDY (NAVAL FACILITIES ENGINEERING SERVICE CENTER, APRIL 1995)
   - REMOVAL SITE EVALUATION FOR QUAY WALL (HNUS, MAY 1995)
2. SITE AND STUDY AREA BOUNDRIES ARE APPROXIMATE.

SITE 1 – CONSTRUCTION BATTALION UNIT (CBU) DRUM STORAGE AREA
SITE 2 – (A) AREA A LANDFILL AND (B) AREA A WETLAND
SITE 3 – (A) AREA A DOWNSTREAM WATER COURSES AND (B) OVERBANK DISPOSAL AREA (OBDA)
SITE 4 – RUBBLE FILL AREA AT BUNKER A-86
SITE 6 – DEFENSE REUTILIZATION AND MARKETING OFFICE (DRMO)
SITE 7 – TORPEDO SHOPS
SITE 8 – GOSS COVE LANDFILL
SITE 9 – OILY WASTEWATER TANK (OT-5)
SITE 10 – LOWER SUBASE-FUEL STORAGE TANKS AND TANK 54-H
SITE 11 – LOWER SUBASE-POWER PLANT OIL TANKS
SITE 13 – LOWER SUBASE-BUILDING 79 WASTE OIL PIT
SITE 14 – OVERBANK DISPOSAL AREA NORTHEAST (OBDANE)
SITE 15 – SPENT ACID STORAGE AND DISPOSAL AREA (SASDA)
SITE 16 – HOSPITAL INCINERATORS
SITE 17 – HAZARDOUS MATERIALS/SOLVENT STORAGE AREA (BUILDING 31)
SITE 18 – SOLVENT STORAGE AREA (BUILDING 33)
SITE 19 – SOLVENT STORAGE AREA (BUILDING 316)
SITE 20 – AREA A WEAPONS CENTER
SITE 21 – BERTH 16
SITE 22 – PIER 33
SITE 23 – FUEL FARM
SITE 24 – CENTRAL PAINT ACCUMULATION AREA (BUILDING 174)
SITE 25 – LOWER SUBASE-CLASSIFIED MATERIALS INCINERATOR

0 800 1600
GRAPHIC SCALE IN FEET

BASE MAP SOURCE: PREPARED BY THE NAVAL SUBMARINE BASE PUBLIC WORKS DEPT., ENGINEERING DIVISION. MARCH 2006, DRAWING NO. A-867.

DRAWN BY DT	DATE 4/25/07	Tetra Tech NUS, Inc.	SITE LOCATION MAP NSB-NLON GROTON, CONNECTICUT	CONTRACT NO. 0777
CHECKED BY NJG	DATE 4/27/07			OWNER NO. 073
REVISED BY	DATE			APPROVED BY CAL DATE 4/27/07
SCALE AS NOTED				DRAWING NO. FIGURE 1-2 REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

ATTACHMENT A.1

TABLES FROM BASEWIDE GROUNDWATER OPERABLE UNIT REPORT

TABLE 13-4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 23
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT
PAGE 1 OF 3

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Tank Farm (Site 23)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics																
	M+P-XYLENES	2		2		ug/L	S23MW02S01	1/7	2	2	N/A	21 N(7)	530 10000 10000	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
95-47-6	O-XYLENE	3		3		ug/L	S23MW02S01	1/7	1	3	N/A	21 N(7)	530 10000 10000	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
127-18-4	TETRACHLOROETHENE	3		3		ug/L	S23MW03D01	1/3	1	3	N/A	0.1 C	5 5 5	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
1330-20-7	XYLENES, TOTAL	5		5		ug/L	S23MW02S01	1/7	1	5	N/A	21 N	530 10000 10000	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
Dissolved Gases																
74-82-8	METHANE	1		920		ug/L	S23MW02S01	7/10	1	920	N/A	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
Semivolatile Organics																
91-20-3	NAPHTHALENE	1.4		1.4		ug/L	S23MW02S01	1/7	0.5 - 5	1.4	N/A	0.62 N	280 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	YES	ASL
Total Metals																
7429-90-5	ALUMINUM	890		2030		ug/L	S23MW02S01	1/7	50.5 - 591	2030	3560	3600 N	N/A 50 to 200 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI, BKG
7440-38-2	ARSENIC	4.7		4.7		ug/L	S23HNUS1101	1/7	2.3	4.7	1.92	N/A	50 10 50	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
7440-39-3	BARIUM	27.2		176		ug/L	S23MW02S01	1/7	18 - 37	176	227	730 N	1000 2000 2000	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-43-9	CADMIUM	0.63		0.63		ug/L	S23HNUS2001	4/7	0.25	0.63	ND	1.8 N	5 5 5	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
7440-70-2	CALCIUM	6270		94100		ug/L	S23MW03D01	10/10	N/A	94100	188000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-47-3	CHROMIUM	10.2	J	43.2		ug/L	S23MW02S01	4/10	6.2	43.2	49.9	11 N(8)	50 100 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-48-4	COBALT	4.5	J	6.4	J	ug/L	S23MW02S01,	4/10	4.2 - 5.2	6.4	48.6	73 N	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-50-8	COPPER	6.8	J	10.7	J	ug/L	S23MW02S01	2/10	6.8	10.7	107	150 N	1300 1300 N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7439-89-6	IRON	202		24800		ug/L	S23MW02S01	9/10	175	24800	28200	2600 N(10)	N/A 300 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI, BKG

TABLE 13-4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 23
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Tank Farm (Site 23)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
7439-92-1	LEAD	1.9	J	31.2		ug/L	S23MW02S01	5/10	1.8	31.2	6.63	N/A	15 15 N/A	CTDEP RSR FED-AL CTDEP-MCL	YES	ASL
7439-95-4	MAGNESIUM	1610		7840		ug/L	S23MW02S01	9/10	544	7840	191000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7439-96-5	MANGANESE	41.4	J	3380		ug/L	S23MW02S01	8/10	8.8 - 12.1	3380	11700	88 N	N/A 50 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
7440-02-0	NICKEL	10	J	33.5		ug/L	S23MW02S01	2/10	9.2 - 9.9	33.5	32.2	73 N	100 100 100	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
7440-09-7	POTASSIUM	1170		7790		ug/L	S23MW02S01	10/10	N/A	7790	70800	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-23-5	SODIUM	7790	J	99200	J	ug/L	S23HNUS201	10/10	N/A	99200	1900000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-62-2	VANADIUM	6.4	J	6.4	J	ug/L	S23MW03D01	1/10	6.3 - 8.2	6.4	10.2	3.6 N	50 N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7440-66-6	ZINC	68.4		68.4		ug/L	S23MW02S01	1/10	10.9 - 43.1	68.4	131	1100 N	5000 5000 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL, BKG
Dissolved Metals																
7440-38-2	ARSENIC, FILTERED	3.1	J	3.1	J	ug/L	S23MW02S01-F	1/2	2.3	3.1	2.55	N/A	50 10 50	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
7440-39-3	BARIUM, FILTERED	33.8		150		ug/L	S23MW02S01-F	2/2	N/A	150	124	260 N	1000 2000 2000	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL
7440-70-2	CALCIUM, FILTERED	33000		45100		ug/L	S23MW02S01-F	2/2	N/A	45100	152000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7439-89-6	IRON, FILTERED	4410		15400		ug/L	S23MW02S01-F	2/2	N/A	15400	25300	2600 N(10)	N/A 300 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	EPAI, BKG
7439-92-1	LEAD, FILTERED	10		10		ug/L	S23MW02S01-F	1/2	1.8	10	2.52	N/A	15 15 N/A	CTDEP RSR FED-AL CTDEP-MCL	NO	BSL
7439-95-4	MAGNESIUM, FILTERED	3770		5830		ug/L	S23MW02S01-F	2/2	N/A	5830	150000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BSL, BKG
7439-96-5	MANGANESE, FILTERED	977		2650		ug/L	S23MW02S01-F	2/2	N/A	2650	9400	88 N	N/A 50 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
7440-09-7	POTASSIUM, FILTERED	5500		7340		ug/L	S23MW02S01-F	2/2	N/A	7340	60000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG
7440-23-5	SODIUM, FILTERED	49300		82600	J	ug/L	S23HNUS201-F	2/2	N/A	82600	1580000	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NUT, BKG

TABLE 13-4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 23
DIRECT CONTACT EXPOSURE SCENARIOS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT
PAGE 3 OF 3

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Tank Farm (Site 23)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	Risk-Based COPC Screening Level(5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Miscellaneous Parameters																
E-14506	ALKALINITY	18		348		mg/L	S23MW03D01	10/10	N/A	348	1950	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BKG
7664-41-7	AMMONIA	0.16	J	0.54	J	mg/L	S23HNUS201	3/3	N/A	0.54	ND	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
7664-41-7	AMMONIA, AS NITROGEN	0.13	J	6.9	J	mg/L	S23MW02S01	6/7	100	6.9	ND	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
000-02-0	CHLORIDE	6.55		124		mg/L	S23MW02S01	10/10	N/A	124	4540	N/A	N/A 250 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL
E-11778	HARDNESS as CaCO3	22.3		257		mg/L	S23MW03D01	10/10	N/A	257	ND	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	NTX
14808-79-8	SULFATE	7.6		47.2		mg/L	S23HNUS2001	10/10	N/A	47.2	45.2	N/A	N/A 250 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BSL
000-09-0	TOTAL DISSOLVED SOLIDS	66.2		519	J	mg/L	S23MW02S01	10/10	N/A	519	6260	N/A	N/A 500 N/A	CTDEP RSR FED-SMCL CTDEP-MCL	NO	BKG
7440-44-0	TOTAL ORGANIC CARBON	1	J	9		mg/L	S23MW04S01	10/10	N/A	9	37.7	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BKG
000-08-9	TOTAL SUSPENDED SOLIDS	6	J	169	J	mg/L	S23MW02S01	6/10	5000	169	236	N/A	N/A N/A N/A	CTDEP RSR FED-MCL CTDEP-MCL	NO	BKG

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC.

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data .
5 The risk-based COPC screening level for tap water use is presented. The value is based on a target Hazard Quotient of 0.1 for noncarcinogens (denoted with a "N" flag) or an incremental cancer risk of 1E-6 for carcinogens (denoted with a "C" flag) (USEPA, Region IX, October 2004, Update December 28, 2004).
6 The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
7 Value is for total xylenes.
8 Value is for hexavalent chromium.

Associated Samples:

S23HNUS1101	S23MW02D01	S23MW04S01
S23HNUS1301	S23MW02D01-D	
S23HNUS2001	S23MW02S01	
S23HNUS201	S23MW02S01-F	
S23HNUS201-F	S23MW03D01	
S23HNUS501	S23MW04D01	

Definitions:

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern
J = Estimated Value
N = Noncarcinogen.
N/A = Not Applicable.
FED-MCL = Federal Maximum Contaminant Level (USEPA, August 2000).
FED-SMCL = Federal Secondary Maximum Contaminant Level (USEPA, August 2000).
FED-AL = Federal Action Level (USEPA, August 2000)
CTDEP-RSR = Connecticut DEP Remediation Standard Regulations, 1996.
CTDEP-MCL = Connecticut Maximum Contaminant Level.

Rationale Codes:

For Selection as a COC:
ASL = Above COC Screening Level/ARAR/TBC.

For Elimination as a COC:
BKG = Within Background Levels.
BSL = Below COC Screening Level/ARAR/TBC
NUT = Essential Nutrient.
NTX = No Toxicity Information.
EPAI = USEPA Region 1 does not advocate evaluation of this chemical.
NV = Miscellaneous parameters are not evaluated in human health risk assessments.

TABLE 13-5

OCCURRENCE, DISTRIBUITON, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 23
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Tank Farm (Site 23)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	CTDEP Surface Water Criteria(5)	CTDEP Vol. Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organics															
	M+P-XYLENES	2		2		ug/L	S23MW02S01	1/10	2	2	NA	NA	21300	NO	BSL
95-47-6	O-XYLENE	3		3		ug/L	S23MW02S01	1/10	1	3	NA	NA	21300	NO	BSL
127-18-4	TETRACHLOROETHENE	3		3		ug/L	S23MW03D01	1/10	1	3	NA	88	1500	NO	BSL
1330-20-7	XYLENES, TOTAL	5		5		ug/L	S23MW02S01	1/10	1	5	NA	NA	21300	NO	BSL
Dissolved Gases															
74-82-8	METHANE	1		920		ug/L	S23MW02S01	7/10	1	920	NA	N/A	N/A	NO	NTX
Semivolatile Organics															
91-20-3	NAPHTHALENE	1.4		1.4		ug/L	S23MW02S01	1/10	0.5 - 5	1.4	NA	N/A	N/A	NO	NTX
Total Metals															
7429-90-5	ALUMINUM	890		2030		ug/L	S23MW02S01	2/10	50.5 - 591	2030	3560	N/A	N/A	NO	BKG
7440-38-2	ARSENIC	4.7		4.7		ug/L	S23HNUS1101	1/10	2.3	4.7	1.92	4	N/A	YES	ASL
7440-39-3	BARIUM	27.2		176		ug/L	S23MW02S01	4/10	18 - 37	176	227	N/A	N/A	NO	BKG
7440-43-9	CADMIUM	0.63		0.63		ug/L	S23HNUS2001	1/10	0.25	0.63	ND	6	N/A	NO	BSL
7440-70-2	CALCIUM	6270		94100		ug/L	S23MW03D01	10/10	N/A	94100	188000	N/A	N/A	NO	BKG
7440-47-3	CHROMIUM	10.2	J	43.2		ug/L	S23MW02S01	4/10	6.2	43.2	49.9	N/A	N/A	NO	BKG
7440-48-4	COBALT	4.5	J	6.4	J	ug/L	S23MW02S01,	4/10	4.2 - 5.2	6.4	48.6	N/A	N/A	NO	BKG
7440-50-8	COPPER	6.8	J	10.7	J	ug/L	S23MW02S01	2/10	6.8	10.7	107	48	N/A	NO	BSL, BKG
7439-89-6	IRON	202		24800		ug/L	S23MW02S01	9/10	175	24800	28200	N/A	N/A	NO	BKG
7439-92-1	LEAD	1.9	J	31.2		ug/L	S23MW02S01	5/10	1.8	31.2	6.63	13	N/A	YES	ASL
7439-95-4	MAGNESIUM	1610		7840		ug/L	S23MW02S01	9/10	544	7840	191000	N/A	N/A	NO	BKG
7439-96-5	MANGANESE	41.4	J	3380		ug/L	S23MW02S01	8/10	8.8 - 12.1	3380	11700	N/A	N/A	NO	BKG
7440-02-0	NICKEL	10	J	33.5		ug/L	S23MW02S01	2/10	9.2 - 9.9	33.5	32.2	880	N/A	NO	BSL
7440-09-7	POTASSIUM	1170		7790		ug/L	S23MW02S01	10/10	N/A	7790	70800	N/A	N/A	NO	BKG
7440-23-5	SODIUM	7790	J	99200	J	ug/L	S23HNUS201	10/10	N/A	99200	1900000	N/A	N/A	NO	BKG
7440-62-2	VANADIUM	6.4	J	6.4	J	ug/L	S23MW03D01	1/10	6.3 - 8.2	6.4	10.2	N/A	N/A	NO	BKG
7440-66-6	ZINC	68.4		68.4		ug/L	S23MW02S01	1/10	10.9 - 43.1	68.4	131	123	N/A	NO	BSL, BKG
Dissolved Metals															
7440-38-2	ARSENIC, FILTERED	3.1	J	3.1	J	ug/L	S23MW02S01-F	1/2	2.3	3.1	2.55	4	N/A	NO	BSL
7440-39-3	BARIUM, FILTERED	33.8		150		ug/L	S23MW02S01-F	2/2	N/A	150	124	N/A	N/A	NO	NTX
7440-70-2	CALCIUM, FILTERED	33000		45100		ug/L	S23MW02S01-F	2/2	N/A	45100	152000	N/A	N/A	NO	BKG
7439-89-6	IRON, FILTERED	4410		15400		ug/L	S23MW02S01-F	2/2	N/A	15400	25300	N/A	N/A	NO	BKG
7439-92-1	LEAD, FILTERED	10		10		ug/L	S23MW02S01-F	1/2	1.8	10	2.52	13	N/A	NO	BSL
7439-95-4	MAGNESIUM, FILTERED	3770		5830		ug/L	S23MW02S01-F	2/2	N/A	5830	150000	N/A	N/A	NO	BKG
7439-96-5	MANGANESE, FILTERED	977		2650		ug/L	S23MW02S01-F	2/2	N/A	2650	9400	N/A	N/A	NO	BKG
7440-09-7	POTASSIUM, FILTERED	5500		7340		ug/L	S23MW02S01-F	2/2	N/A	7340	60000	N/A	N/A	NO	BKG
7440-23-5	SODIUM, FILTERED	49300		82600	J	ug/L	S23HNUS201-F	2/2	N/A	82600	1580000	N/A	N/A	NO	BKG
Miscellaneous Parameters															
E-14506	ALKALINITY	18		348		mg/L	S23MW03D01	10/10	N/A	348	1950	N/A	N/A	NO	BKG
7664-41-7	AMMONIA	0.16	J	0.54	J	mg/L	S23HNUS201	3/3	N/A	0.54	ND	N/A	N/A	NO	NTX
7664-41-7	AMMONIA, AS NITROGEN	0.13	J	6.9	J	mg/L	S23MW02S01	6/7	100	6.9	ND	N/A	N/A	NO	NTX
000-02-0	CHLORIDE	6.55		124		mg/L	S23MW02S01	10/10	N/A	124	4540	N/A	N/A	NO	BKG

TABLE 13-5

OCCURRENCE, DISTRIBUITON, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER AT SITE 23
MIGRATION PATHWAYS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Tank Farm (Site 23)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	CTDEP Surface Water Criteria(5)	CTDEP Vol. Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(5)
E-11778	HARDNESS as CaCO3	22.3		257		mg/L	S23MW03D01	10/10	N/A	257	ND	N/A	N/A	NO	NTX
14808-79-8	SULFATE	7.6		47.2		mg/L	S23HNUS2001	10/10	N/A	47.2	45.2	N/A	N/A	NO	NTX
000-09-0	TOTAL DISSOLVED SOLIDS	66.2		519	J	mg/L	S23MW02S01	10/10	N/A	519	6260	N/A	N/A	NO	BKG
7440-44-0	TOTAL ORGANIC CARBON	1	J	9		mg/L	S23MW04S01	10/10	N/A	9	37.7	N/A	N/A	NO	BKG
000-08-9	TOTAL SUSPENDED SOLIDS	6	J	169	J	mg/L	S23MW02S01	6/10	5000	169	236	N/A	N/A	NO	BKG

A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC.

Footnotes:

1 Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 Values presented are sample-specific quantitation limits.
3 The maximum detected concentration is used for screening purposes.
4 95% Upper Tolerance Limit (UTL) of site background data.
5 Connecticut DEP Surface Water Protection criteria.
6 Connecticut DEP Volatilization criteria for residential exposures.
7 The chemical is selected as a COPC if the maximum detected concentration exceeds the CTDEP surface water protection or volatilization criteria.

Associated Samples:

S23HNUS1101	S23MW02D01	S23MW04S01
S23HNUS1301	S23MW02D01-D	
S23HNUS2001	S23MW02S01	
S23HNUS201	S23MW02S01-F	
S23HNUS201-F	S23MW03D01	
S23HNUS501	S23MW04D01	

Definitions:

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COC = Chemical of Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.

Rationale Codes:

For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BKG = Within Background Levels.
BSL = Below COPC Screening Level/ARAR/TBC.
NTX = No Toxicity Information.

TABLE 13-8

SUMMARY OF CANCER RISKS AND HAZARD INDICES FOR SITE 23
REASONABLE MAXIMUM EXPOSURES
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $> 10^{-4}$	Chemicals with Cancer Risks $> 10^{-5}$ and $\leq 10^{-4}$	Chemicals with Cancer Risks $> 10^{-6}$ and $\leq 10^{-5}$	Hazard Index	Chemicals with HI > 1
Construction Worker	Groundwater	Dermal Contact	1.3E-09	- -	- -	- -	0.0002	- -
Adult Resident	Groundwater	Ingestion	1.8E-06	- -	- -	Tetrachloroethene	0.01	- -
		Dermal Contact	8.5E-07	- -	- -	- -	0.005	- -
		Inhalation (1)	1.8E-06	- -	- -	Tetrachloroethene	0.008	- -
		Total	4.5E-06	- -	- -	Tetrachloroethene	0.02	- -

Notes:
1 - Inhalation risk is assumed to be equal to risk from ingestion for volatiles.

ATTACHMENT A.2

TABLES FROM STORM SEWER REHABILITATION

TABLE 1
GROTON STORM SEWER REHABILITATION PROJECT
UNDERDRAIN WATER SAMPLING FOR OIL/WATER SEPARATOR (OWS) DETERMINATION
MONTHLY SAMPLING RESULTS

	Sample # / Date sampled	OWS-072500 / 7/25/2000	OWS-082300 / 8/23/2000	OWS-100400 / 10/4/2000	OWS-011701 / 1/17/2001		OWS-031501 / 3/15/2001		OWS-041901 / 4/19/2001		OWS-052301 / 5/23/2001		CTDEP RSR Surface Water Protection Criteria[1]	CTDEP RSR Groundwater Volatilization Criteria[2]
ANALYSIS	METHOD	RESULTS	RESULTS	RESULTS	RESULTS		RESULTS		RESULTS		RESULTS			
Fuel Type Fingerprint	8015	ND	ND	ND	NA		NA		E		E		NA	NA
PH	EPA 150.1	6.2 std. Units	6.3 std. Units	6.3 std. Units	NA		NA		6.23		6.64		NA	NA
Total petroleum hydrocarbons	418.1	1.1 mg/l	<1.0 mg/l	1.0 mg/l	NA		NA		5.2 mg/l		0.08 mg/l		NA	NA
Oil and grease	EPA 413.1	<5.0 mg/l	<5.0 mg/l	<5.0 mg/l	NA		NA		9.2 mg/l		16 mg/l		NA	NA
Total suspended solids	EPA 160.2	62 mg/l	720 mg/l	1400 mg/l	<5.0 mg/l		23 mg/l		160 mg/l		273 mg/l		NA	NA
Metals:	6010B	NA	ug/l	ug/l	ug/l		ug/l		ug/l		ug/l		ug/l	
					Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved		
Aluminum		NA	11300	15500	1360	492	1670	ND	2150	16.5 B	2540	ND		
Antimony		NA	6.4	4.1	ND	ND	ND	ND	ND	ND	3.2B	ND	86000	NA
Arsenic		NA	13.4	22.2	ND	ND	5.6 B	ND	8.1 B	2.8 B	9.1B	ND	4	NA
Barium		NA	169	223	64.5 B	56.3 B	61.6 B	33.4 B	82.7 B	45.3 B	96.7B	38.3B	NA	NA
Beryllium		NA	2.6	0.3	ND	1.7 B	ND	ND	0.15 B	ND	0.98B	0.80B	4	NA
Cadmium		NA	0.8	0.8	ND	ND	ND	ND	ND	ND	ND	ND	6	NA
Calcium		NA	32500	35800	31100	29700	35400	31300	36600	33200	28200	28600	NA	NA
Chromium		NA	19.6	28.4	2.2 B	ND	2.4 B	ND	4.0 B	ND	6.5B	ND	110	NA
Cobalt		NA	9.9	17	2.4 B	ND	1.6 B	ND	3.2 B	ND	4.4B	ND	NA	NA
Copper		NA	36	39.5	ND	ND	6.1 B	ND	4.1 B	ND	10.6B	3.3B	48	NA
Iron		NA	62100	116000	15100	11100	24100	76.6 B	32600	258	62500	125	NA	NA
Lead		NA	79.7	93.7	13.2	7.9	11.1	ND	16.7	ND	28.5	ND	13	NA
Magnesium		NA	9950	12000	7350	6560	8350	6850	8950	7560	6620	6400	NA	NA
Manganese		NA	1540	2220	884	801	896	582	1150	515	1630	476	NA	NA
Mercury		NA	0.1	0.2	ND	ND	ND	ND	ND	ND	ND	0.25	0.4	NA
Nickel		NA	13.2	18.3	ND	ND	ND	3.3 B	ND	ND	ND	ND	880	NA
Potassium		NA	8600	9060	5430	5100	7100	4770 B	6400	5090	4270B	4330B	NA	NA
Selenium		NA	2.2	12.5	ND	ND	ND	ND	ND	ND	5.4	ND	50	NA
Silver		NA	2.8	4	ND	ND	ND	ND	ND	ND	1.9B	ND	12	NA
Sodium		NA	39500	51800	41800	37500	46100	39700	48400	44700	40400	45400	NA	NA
Thallium		NA	3.2	3.2	ND	ND	ND	ND	ND	ND	ND	3.9B	63	NA
Vanadium		NA	40.5	52.7	4.0 B	ND	8.7 B	ND	ND	ND	ND	ND	NA	NA
Zinc		NA	228	231	53.5	43.5	48.5	7.0 B	58.1	23.1	87.9	44.0	123	NA
Cyanide		NA	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
VOA	OLM2.1													
Tetrachloroethene					ND		ND		ND		0.5J		88	340
VOA (TIC)	OLM2.1													
Methane, chlorodifluoro-					4.0 J		ND		ND		ND		NA	NA
Ethane, 1,1,2-trichloro-1,2,					2.9 J		ND		8.5 J		1.1 J		NA	NA
SVOA	8270C													
Dimethylphthalate					ND		ND		ND		1.1		NA	NA
Diethylphthalate					ND		ND		ND		20		NA	NA
Di-n-butylphthalate					ND		ND		ND		10		NA	NA
Bis(2-Ethylhexyl)phthalate					ND		ND		ND		20		59	NA
PAH	8310													
Naphthalene					ND		ND		ND		0.37J		NA	NA
Phenanthrene					8.00		ND		ND		0.58		0.3	NA
Fluoranthene					3.00		ND		ND		0.58		3700	NA
Pyrene					ND		ND		ND		0.52		110000	NA
Benzo(a)anthracene					ND		ND		ND		0.25J		0.3	NA
Chrysene					ND		ND		ND		0.21J		NA	NA
Benzo(b)fluoranthene					ND		ND		ND		0.45J		0.3	NA
Benzo(k)fluoranthene					ND		ND		ND		2.00		0.3	NA
Benzo(a)pyrene					ND		ND		ND		0.62		NA	NA
Dibenzo(a,h)anthracene					ND		ND		ND		0.50		NA	NA
Benzo(ghi)perylene					ND		ND		ND		0.62		NA	NA

Notes:
ND = Not Detected
NA = Not Analyzed
NR = Not reported
J = Indicates an estimated value
B = Indicates the analyte was found in the blank as well as the sample
E = No Calibrated Fuel Type Detected
Pesticide/PCB compounds were not detected (Method OLM2.1)
1 - CTDEP Remediation Standard Regulations, Residential, 1996.
2 - Connecticut's Proposed Revisions Remediation Standard Regulations, Volatilization Criteria, March 2003.
Shading indicates that concentration exceeds the screening criteria.

ATTACHMENT A.3

RISKS BASED ON STORM SEWER REHABILIATION

GROUNDWATER ANALYTICAL SAMPLING RESULTS

TABLE 4.1.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Construction Workers	Adult	Site 23	DAevent	Dermally Absorbed Dose per Event	Calculated	mg/cm2-event	U.S. EPA, 2004	Dermally Absorbed Dose (mg/kg/day) =
				SA	Skin Surface Available for Contact	3300	cm2	U.S. EPA, 2004	
				EV	Event Frequency	1	events/day	(1)	DAevent x EV x EF x ED x SA
				ET	Exposure Time	4	hours/day	(1)	BW x AT
				EF	Exposure Frequency	30	days/year	(1)	
				ED	Exposure Duration	1	years	(1)	See text for calculation of DAevent.
				BW	Body Weight	70	kg	U.S. EPA, 1989	
				AT-C	Averaging Time (Cancer)	25550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	365	days	U.S. EPA, 1989	

Sources:

1 - Professional judgment.

U.S. EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

Unit Intake Calculations

Ingestion Intake = (IR-GW x EF x ED)/(BW x AT)

Dermal Intake = (SA x EV x EF x ED)/(BW x AT)

Cancer Ingestion Intake = NA

Noncancer Ingestion Intake = NA

Cancer Dermal Intake = 5.54E-02

Noncancer Dermal Intake = 3.87E+00

TABLE 4.2.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Construction Workers	Adult	Site 23	CA	Chemical concentration in air	Calculated	mg/m3	VDEQ, 2004	Intake (mg/kg/day) =
				CW	Chemical concentration in water.	Average	ug/L		
				CF	Conversion Factor	0.001	mg/ug	--	CA x IR x ET x EF x ED
				IR	Inhalation Rate	2.5	m3/hour	U.S. EPA, 1993	BW x AT
				ET	Exposure Time	4	hours/day	(1)	
				EF	Exposure Frequency	30	days/year	(1)	CA = CW x CF x VF
				ED	Exposure Duration	1	years	(1)	
				BW	Body Weight	70	kg	U.S. EPA, 1989	
				AT-C	Averaging Time (Cancer)	25550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	365	days	U.S. EPA, 1989	
				VF	Volatilization Factor	Calculated	(mg/m3)/(mg/L)	VDEQ, 2004	

Notes:

1 - Professional judgment.

U.S. EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

U.S. EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

VDEQ, 2004: Virginia Department of Environmental Quality (VDEQ, online- http://www.deq.state.va.us/vrprisk/homepage.html).

Unit Intake Calculations

Inhalation Intake = (IR x ET x EF x ED)/(BW x AT)

Cancer Inhalation Intake = 1.68E-04

Noncancer Inhalation Intake = 1.17E-02

TABLE 4.3.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Residents	Child	Site 23	CGW	Chemical Concentration in Groundwater	Max or 95% UCL	mg/kg	U.S. EPA, 2002a	Chronic Daily Intake (CDI) (mg/kg/day) =
				CF	Conversion Factor	0.001	mg/ug	–	
				IR-GW	Ingestion Rate of Groundwater	1.5	L/day	U.S. EPA, 1994	CW x CF x IR-GW x EF x ED
				EF	Exposure Frequency	350	days/year	U.S. EPA, 1994	BW x AT
				ED1	Exposure Duration (Age 0 - 2)	2	years	U.S. EPA, 1989	
				ED2	Exposure Duration (Age 2 - 6)	4	years	U.S. EPA, 1989	
				BW	Body Weight	15	kg	U.S. EPA, 1991	
				AT-C	Averaging Time (Cancer)	25550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2190	days	U.S. EPA, 1989	
Dermal	Residents	Child	Site 23	Daevent	Dermally Absorbed Dose per Event	Calculated	mg/cm2-event	U.S. EPA, 2004	Dermally Absorbed Dose (mg/kg/day) =
				SA	Skin Surface Available for Contact	6,600	cm2	U.S. EPA, 2004	
				EV	Event Frequency	1	events/day	U.S. EPA, 2004	DAevent x EV x EF x ED x SA
				ET	Exposure Time	0.25	hours/day	U.S. EPA, 1997	BW x AT
				EF	Exposure Frequency	350	days/year	U.S. EPA, 1994	
				ED1	Exposure Duration (Age 0 - 2)	2	years	U.S. EPA, 1989	See text for calculation of DAevent.
				ED2	Exposure Duration (Age 2 - 6)	4	years	U.S. EPA, 1989	
				BW	Body Weight	15	kg	U.S. EPA, 1991	
				AT-C	Averaging Time (Cancer)	25550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2190	days	U.S. EPA, 1989	

Sources:

U.S. EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

U.S. EPA, 1991: Risk Assessment Guidance for Superfund - Supplemental Guidance- Standard Default Exposure Factors Interim Final.

U.S. EPA, 1994: U.S. EPA Region I Risk Updates, August 1994.

U.S. EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa

U.S. EPA, 2002:Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. OSWER 9285.6-10, December.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

Unit Intake Calculations

Ingestion Intake = (IR-GW x EF x ED)/(BW x AT)

Dermal Intake = (SA x EV x EF x ED)/(BW x AT)

Cancer Ingestion Intake (Age 0 - 2) = 2.74E-06 Cancer Dermal Intake (Age 0 - 2) = 1.21E+01

Cancer Ingestion Intake (Age 2 - 6) = 5.48E-06 Cancer Dermal Intake (Age 2 - 6) = 2.41E+01

Noncancer Ingestion Intake = 9.59E-05 Noncancer Dermal Intake = 4.22E+02

TABLE 4.4.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Residents	Adult	Site 23	CGW	Chemical Concentration in Groundwater	95% UCL or Max	ug/L	U.S. EPA, 2002	Chronic Daily Intake (CDI) (mg/kg/day) =
				CF	Conversion Factor	0.001	mg/ug	--	
				IR-GW	Ingestion Rate of Groundwater	2	L/day	U.S. EPA, 1994	CW x CF x IR-GW x EF x ED
				EF	Exposure Frequency	350	days/year	U.S. EPA, 1994	BW x AT
				ED1	Exposure Duration (Age 10 - 16)	10	years	U.S. EPA, 1989	
				ED2	Exposure Duration (Age 16 - 30)	14	years	U.S. EPA, 1989	
				BW	Body Weight	70	kg	U.S. EPA, 1989	
				AT-C	Averaging Time (Cancer)	25,550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,650	days	U.S. EPA, 1989	
Dermal	Residents	Adult	Site 23	Daevent	Dermally Absorbed Dose per Event	Calculated	mg/cm2-event	U.S. EPA, 2004	Dermally Absorbed Dose (mg/kg/day) =
				SA	Skin Surface Available for Contact	18,000	cm2	U.S. EPA, 2004	
				EV	Event Frequency	1	events/day	U.S. EPA, 2004	DAevent x EV x EF x ED x SA
				ET	Exposure Time	0.25	hours/day	U.S. EPA, 2004	BW x AT
				EF	Exposure Frequency	350	days/year	U.S. EPA, 1994	
				ED1	Exposure Duration (Age 10 - 16)	10	years	U.S. EPA, 1989	See text for calculation of DAevent.
				ED2	Exposure Duration (Age 16 - 30)	14	years	U.S. EPA, 1989	
				BW	Body Weight	70	kg	U.S. EPA, 1989	
				AT-C	Averaging Time (Cancer)	25,550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,650	days	U.S. EPA, 1989	

Sources:

U.S. EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

U.S. EPA, 1991: Risk Assessment Guidance for Superfund - Supplemental Guidance- Standard Default Exposure Factors Interim Final.

U.S. EPA, 1994: U.S. EPA Region I Risk Updates, August 1994.

U.S. EPA, 1997: Exposure Factors Handbook. U.S. EPA/600/8-95/002FA.

U.S. EPA, 2002: Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. OSWER 9285.6-10.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

Unit Intake Calculations

Ingestion Intake = (IR-GW x EF x ED)/(BW x AT)

Dermal Intake = (SA x EV x EF x ED)/(BW x AT)

Cancer Ingestion Intake Age 10 - 16) = 3.91E-06

Cancer Ingestion Intake Age 16 - 30) = 5.48E-06

Cancer Dermal Intake Age 10 - 16) = 3.52E+01

Cancer Dermal Intake (Age 16 - 30) = 4.93E+01

Noncancer Ingestion Intake = 6.58E-05

Noncancer Dermal Intake = 5.92E+02

TABLE 4.5
INTERMEDIATE VARIABLES FOR CALCULATING DA(EVENT)
SITE 23 - STORM SEWER
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Media	Dermal Absorption Fraction (soil)	FA	Kp		T(event)		Tau		T*		B
			Value	Value	Units	Value	Units	Value	Units	Value	Units	Value
Volatile Organic Compounds												
Tetrachloroethene	Groundwater	NA	1	3.3E-02	cm/hr	4	hr	9.1E-01	hr	2.2E+00	hr	1.7E-01
Semivolatile Organic Compounds												
Benzo(a)anthracene[(1)]	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene[(1)]	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene[(1)]	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene[(1)]	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene[(1)]	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-Ethylhexyl)phthalate	Groundwater	NA	0.8	2.5E-02	cm/hr	4	hr	1.7E+01	hr	4.0E+01	hr	1.9E-01
Chrysene[(1)]	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene[(1)]	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diethylphthalate	Groundwater	NA	1	3.9E-03	cm/hr	4	hr	1.9E+00	hr	4.5E+00	hr	2.2E-02
Dimethylphthalate	Groundwater	NA	1	1.4E-03	cm/hr	4	hr	1.3E+00	hr	3.1E+00	hr	7.4E-03
Di-n-butylphthalate	Groundwater	NA	0.9	2.4E-02	cm/hr	4	hr	3.9E+00	hr	9.3E+00	hr	1.5E-01
Fluoranthene[(1)]	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	Groundwater	NA	1	4.7E-02	cm/hr	4	hr	5.6E-01	hr	1.3E+00	hr	2.0E-01
Phenanthrene[(1)]	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	Groundwater	NA	1	1.9E-01	cm/hr	4	hr	1.4E+00	hr	5.5E+00	hr	1.1E+00
Inorganics												
Aluminum	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Antimony	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Arsenic	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Barium	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Beryllium	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Chromium	Groundwater	NA	1	2.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Cobalt	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Copper	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Iron	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Manganese	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Selenium	Groundwater	NA	1	1.0E-03	cm/hr	4	hr	NA	NA	NA	NA	NA
Silver	Groundwater	NA	1	6.0E-04	cm/hr	4	hr	NA	NA	NA	NA	NA
Zinc	Groundwater	NA	1	6.0E-04	cm/hr	4	hr	NA	NA	NA	NA	NA

Notes:
All values from EPA's Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final, July 2004.
1 - RAGS Part E recommends that dermal exposures to PAHs in water should not be quantitatively evaluated in the risk assessment.
FA = Fraction Absorbed Water
Kp = Dermal Permeability Coefficient of Compound in Water
T(event) = Event Duration
Tau = Lag Time
T* = Time to Reach Steady-State
B = Dimensionless Ratio of the Permeability Coefficient of a Compound Through the Stratum Corneum Relative to its Permeability Coefficient Across the Viable Epidermis
NA = Not applicable.

TABLE 5.1
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
SITE 23 - STORM SEWER
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal(1)	Absorbed RfD for Dermal(2)		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD:Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Volatile Organic Compounds										
Tetrachloroethene	Chronic	1.0E-02	mg/kg/day	1	1.0E-02	mg/kg/day	Liver	1000/1	IRS	4/23/2008
Semivolatile Organic Compounds										
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene(3)	Chronic	3.0E-02	mg/kg/day	1	3.0E-02	mg/kg/day	Kidney	3000/1	IRIS	4/23/2008
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	Chronic	2.0E-02	mg/kg/day	1	2.0E-02	mg/kg/day	Liver	1000/1	IRIS	4/23/2008
Chrysene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diethylphthalate	Chronic	8.0E-01	mg/kg/day	1	8.0E-01	mg/kg/day	Body Weight	1000/1	IRIS	4/23/2008
Dimethylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-butylphthalate	Chronic	1.0E-01	mg/kg/day	1	1.0E-01	mg/kg/day	Mortality	1000/1	IRIS	4/23/2008
Fluoranthene	Chronic	4.0E-02	mg/kg/day	1	4.0E-02	mg/kg/day	Liver	3000/1	IRIS	4/23/2008
Naphthalene	Chronic	2.0E-02	mg/kg/day	1	2.0E-02	mg/kg/day	Body Weight	3000/1	IRIS	4/23/2008
Phenanthrene(3)	Chronic	3.0E-02	mg/kg/day	1	3.0E-02	mg/kg/day	Kidney	3000/1	IRIS	4/23/2008
Pyrene	Chronic	3.0E-02	mg/kg/day	1	3.0E-02	mg/kg/day	Kidney	3000/1	IRIS	4/23/2008
Inorganics										
Aluminum	Chronic	1.0E+00	mg/kg/day	1	1.0E+00	mg/kg/day	CNS	100	PPRTV	10/23/2006
Antimony	Chronic	4.0E-04	mg/kg/day	0.15	6.0E-05	mg/kg/day	Blood	1000/1	IRIS	4/23/2008
Arsenic	Chronic	3.0E-04	mg/kg/day	1	3.0E-04	mg/kg/day	Skin, CVS	3/1	IRIS	4/23/2008
Barium	Chronic	2.0E-01	mg/kg/day	0.07	1.4E-02	mg/kg/day	Kidney	300/1	IRIS	4/23/2008
Beryllium	Chronic	2.0E-03	mg/kg/day	0.007	1.4E-05	mg/kg/day	GS	300/1	IRIS	4/23/2008
Chromium	Chronic	3.0E-03	mg/kg/day	0.025	7.5E-05	mg/kg/day	Fetotoxicity, GS, Bone	300/3	IRIS	4/23/2008
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	Chronic	4.0E-02	mg/kg/day	1	4.0E-02	mg/kg/day	GS	NA	HEAST	7/1997
Iron	Chronic	7.0E-01	mg/kg/day	1	7.0E-01	mg/kg/day	GS	1.5	PPRTV	9/11/2006
Manganese	Chronic	2.4E-02	mg/kg/day	0.04	9.6E-04	mg/kg/day	CNS	1/3	IRIS	4/23/2008
Selenium	Chronic	5.0E-03	mg/kg/day	1	5.0E-03	mg/kg/day	Skin	3/1	IRIS	4/23/2008
Silver	Chronic	5.0E-03	mg/kg/day	0.04	2.0E-04	mg/kg/day	Skin	3/1	IRIS	4/23/2008
Zinc	Chronic	3.0E-01	mg/kg/day	1	3.0E-01	mg/kg/day	Blood	3/1	IRIS	4/23/2008

Notes:
1 - U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.
2 - Adjusted dermal RfD = Oral RfD x Oral Absorption Efficiency for Dermal.
3 - Values are for pyrene.

Definitions:
CNS = Central Nervous System
CVS = Cardiovascular system
USEPA(1) = Draft Trichloroethylene Health Risk Assessment: Synthesis and Characterization, August 2001.
USEPA III = U.S. EPA Region 3 RBC Table, October 11, 2007.
GS = Gastrointestinal system
IRIS = Integrated Risk Information System
NA = Not Applicable

TABLE 5.2
NON-CANCER TOXICITY DATA -- INHALATION
SITE 23 - STORM SEWER
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Extrapolated RfD (1)		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfC : Target Organ(s)	
		Value	Units	Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Volatile Organic Compounds									
Tetrachloroethene	Chronic	2.8E-01	mg/m^3	8.0E-02	(mg/kg/day)	Liver	NA	USEPA III	10/11/2007
Semivolatile Organic Compounds									
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diethylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dimethylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-butylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	Chronic	3.0E-03	mg/m^3	8.6E-04	(mg/kg/day)	Nasal	3000/1	IRIS	4/23/2008
Phenanthrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Inorganics									
Aluminum	Chronic	0.005	mg/m3	1.4E-03	(mg/kg/day)	CNS	300	PPRTV	10/23/2006
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barium	Chronic	5.0E-04	mg/m3	1.4E-04	(mg/kg/day)	Fetotoxicity	1000	HEAST	7/97
Beryllium	Chronic	2.0E-05	mg/m3	5.7E-06	(mg/kg/day)	GS	10/1	IRIS	4/23/2008
Chromium	Chronic	1.0E-04	mg/m^3	2.9E-05	(mg/kg/day)	Lungs	300/1	IRIS	4/23/2008
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	Chronic	5.0E-05	mg/m^3	1.4E-05	(mg/kg/day)	CNS	1000/1	IRIS	4/23/2008
Selenium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
1 - Extrapolated RfD = RfC $*20m^3$/day / 70 kg

Definitions:
CNS = Central Nervous System
USEPA III = U.S. EPA Region 3 RBC Table, October 11, 2007.
GS = Gastrointestinal
HEAST= Health Effects Assessment Summary Tables
IRIS = Integrated Risk Information System
NA = Not Applicable

TABLE 6.1
CANCER TOXICITY DATA -- ORAL/DERMAL
SITE 23 - STORM SEWER
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal(1)	Absorbed Cancer Slope Factor for Dermal(2)		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units		Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Volatile Organic Compounds								
Tetrachloroethene	5.4E-01	(mg/kg/day)-1	1	5.4E-01	(mg/kg/day)-1	NA	IRIS	4/23/2008
Semivolatile Organic Compounds								
Benzo(a)anthracene	7.3E-01	$(mg/kg/day)^{-1}$	1	7.3E-01	$(mg/kg/day)^{-1}$	B2	USEPA(1)	7/1993
Benzo(a)pyrene	7.3E+00	$(mg/kg/day)^{-1}$	1	7.3E+00	$(mg/kg/day)^{-1}$	B2	IRIS	7/20/2007
Benzo(b)fluoranthene	7.3E-01	$(mg/kg/day)^{-1}$	1	7.3E-01	$(mg/kg/day)^{-1}$	B2	USEPA(1)	7/1993
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	D	IRIS	
Benzo(k)fluoranthene	7.3E-02	$(mg/kg/day)^{-1}$	1	7.3E-02	$(mg/kg/day)^{-1}$	B2	USEPA(1)	7/1993
Bis(2-ethylhexyl)phthalate	1.4E-02	$(mg/kg/day)^{-1}$	1	1.4E-02	$(mg/kg/day)^{-1}$	B2	IRIS	4/23/2008
Chrysene	7.3E-03	$(mg/kg/day)^{-1}$	1	7.3E-03	$(mg/kg/day)^{-1}$	B2	USEPA(1)	7/1993
Dibenzo(a,h)anthracene	7.3E+00	$(mg/kg/day)^{-1}$	1	7.3E+00	$(mg/kg/day)^{-1}$	B2	USEPA(1)	7/1993
Diethylphthalate	NA	NA	NA	NA	NA	D	IRIS	4/23/2008
Dimethylphthalate	NA	NA	NA	NA	NA	D	IRIS	4/23/2008
Di-n-butylphthalate	NA	NA	NA	NA	NA	D	IRIS	4/23/2008
Fluoranthene	NA	NA	NA	NA	NA	D	IRIS	4/23/2008
Naphthalene	NA	NA	NA	NA	NA	C	IRIS	4/23/2008
Phenanthrene	NA	NA	NA	NA	NA	D	IRIS	4/23/2008
Pyrene	NA	NA	NA	NA	NA	D	IRIS	4/23/2008
Inorganics								
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	1.5E+00	$(mg/kg/day)^{-1}$	1	1.5E+00	$(mg/kg/day)^{-1}$	A	IRIS	4/23/2008
Barium	NA	NA	NA	NA	NA	D	IRIS	4/23/2008
Beryllium	NA	NA	NA	NA	NA	B1	IRIS	4/23/2008
Chromium	NA	NA	NA	NA	NA	D	IRIS	4/23/2008
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	D	IRIS	4/23/2008
Iron	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	D	IRIS	4/23/2008
Selenium	NA	NA	NA	NA	NA	D	IRIS	4/23/2008
Silver	NA	NA	NA	NA	NA	D	IRIS	4/23/2008
Zinc	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
1 - U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.
2 - Adjusted cancer slope factor for dermal = Oral cancer slope factor / Oral Absorption Efficiency for Dermal.
USEPA III = U.S. EPA Region 3 RBC Table, October 11, 2007.
IRIS = Integrated Risk Information System.
NA = Not Available.

EPA Group:
A - Human carcinogen.
B1 - Probable human carcinogen - indicates that limited human data are available.
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans .
C - Possible human carcinogen.
D - Not classifiable as a human carcinogen.
E - Evidence of noncarcinogenicity.

USEPA(1) = U.S. EPA, Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons, July 1993, EPA/600/R-93/089.

TABLE 6.2
CANCER TOXICITY DATA – INHALATION
SITE 23 - STORM SEWER
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Unit Risk		Inhalation Cancer Slope Factor(1)		Weight of Evidence/ Cancer Guideline Description	Unit Risk : Inhalation CSF	
	Value	Units	Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Volatile Organic Compounds							
Tetrachloroethene	5.7E-06	$(ug/m^3)^{-1}$	2.0E-02	$(mg/kg/day)^{-1}$	NA	USEPA III	10/11/2007
Semivolatile Organic Compounds							
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	8.9E-04	$(ug/m^3)^{-1}$	3.1E+00	$(mg/kg/day)^{-1}$	NA	USEPA III	10/11/2007
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	D	IRIS	4/23/2008
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA
Bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	B2	IRIS	4/23/2008
Chrysene	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA
Diethylphthalate	NA	NA	NA	NA	D	IRIS	4/23/2008
Dimethylphthalate	NA	NA	NA	NA	D	IRIS	4/23/2008
Di-n-butylphthalate	NA	NA	NA	NA	D	IRIS	4/23/2008
Fluoranthene	NA	NA	NA	NA	D	IRIS	4/23/2008
Naphthalene	NA	NA	NA	NA	C	IRIS	4/23/2008
Phenanthrene	NA	NA	NA	NA	D	IRIS	4/23/2008
Pyrene	NA	NA	NA	NA	D	IRIS	4/23/2008
Inorganics							
Aluminum	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA
Arsenic	4.3E-03	$(ug/m^3)^{-1}$	1.5E+01	$(mg/kg/day)^{-1}$	A	IRIS	4/23/2008
Barium	NA	NA	NA	NA	D	IRIS	4/23/2008
Beryllium	2.4E-03	$(ug/m^3)^{-1}$	8.4E+00	$(mg/kg/day)^{-1}$	B1	IRIS	4/23/2008
Chromium	1.2E-02	$(ug/m^3)^{-1}$	4.2E+01	$(mg/kg/day)^{-1}$	A	IRIS	4/23/2008
Cobalt	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	D	IRIS	4/23/2008
Iron	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	D	IRIS	4/23/2008
Selenium	NA	NA	NA	NA	D	IRIS	4/23/2008
Silver	NA	NA	NA	NA	D	IRIS	4/23/2008
Zinc	NA	NA	NA	NA	D	IRIS	4/23/2008

Notes:
1 - Inhalation CSF = Unit Risk * 70 kg / $20m^3$/day.
Definitions:
IRIS = Integrated Risk Information System.
NA = Not Available.
USEPA III = U.S. EPA Region 3 RBC Table, October 11, 2007.

EPA Group:
A - Human carcinogen.
B1 - Probable human carcinogen - indicates that limited human data are available.
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans .
C - Possible human carcinogen.
D - Not classifiable as a human carcinogen.
E - Evidence of noncarcinogenicity.

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Construction Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Site 23	Dermal	Aluminum	2540	ug/L	5.6E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.9E-05	(mg/kg/day)	1.0E+00	(mg/kg/day)	0.00004
				Antimony	3.20	ug/L	7.1E-10	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	5.0E-08	(mg/kg/day)	6.0E-05	(mg/kg/day)	0.0008
				Arsenic	9.10	ug/L	2.0E-09	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	3.0E-09	1.4E-07	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.0005
				Barium	96.7	ug/L	2.1E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.5E-06	(mg/kg/day)	1.4E-02	(mg/kg/day)	0.0001
				Beryllium	0.960	ug/L	2.2E-10	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.5E-08	(mg/kg/day)	1.4E-05	(mg/kg/day)	0.001
				Chromium	6.50	ug/L	2.9E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	2.0E-07	(mg/kg/day)	7.5E-05	(mg/kg/day)	0.003
				Cobalt	4.40	ug/L	9.7E-10	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	6.8E-08	(mg/kg/day)	NA	(mg/kg/day)	–
				Copper	10.6	ug/L	2.3E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.6E-07	(mg/kg/day)	4.0E-02	(mg/kg/day)	0.000004
				Iron	62500	ug/L	1.4E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	9.7E-04	(mg/kg/day)	7.0E-01	(mg/kg/day)	0.001
				Manganese	1630	ug/L	3.6E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	2.5E-05	(mg/kg/day)	9.6E-04	(mg/kg/day)	0.03
				Selenium	5.40	ug/L	1.2E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	8.4E-08	(mg/kg/day)	5.0E-03	(mg/kg/day)	0.00002
				Silver	1.90	ug/L	2.5E-10	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.8E-08	(mg/kg/day)	2.0E-04	(mg/kg/day)	0.00009
				Zinc	87.9	ug/L	1.2E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	8.2E-07	(mg/kg/day)	3.0E-01	(mg/kg/day)	0.000003
				Tetrachloroethene	0.500	ug/L	5.1E-09	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	2.8E-09	3.6E-07	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.00004
				Dimethylphthalate	1.10	ug/L	5.6E-10	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.9E-08	(mg/kg/day)	NA	(mg/kg/day)	–
				Diethylphthalate	20.0	ug/L	3.3E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	2.3E-06	(mg/kg/day)	8.0E-01	(mg/kg/day)	0.000003
				Di-n-butylphthalate	10.0	ug/L	1.3E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	9.1E-06	(mg/kg/day)	1.0E-01	(mg/kg/day)	0.00009
				Bis(2-Ethylhexyl)phthalate	20.0	ug/L	5.0E-07	(mg/kg/day)	1.4E-02	(mg/kg/day)$^{-1}$	7.0E-09	3.5E-05	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.002
				Naphthalene	0.370	ug/L	4.5E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.1E-07	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.00002
				Phenanthrene	0.580	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Fluoranthene	0.580	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	4.0E-02	(mg/kg/day)	--
				Pyrene	0.520	ug/L	3.7E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	2.6E-06	(mg/kg/day)	3.0E-02	(mg/kg/day)	0.00009
				Benzo(a)anthracene	0.250	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Chrysene	0.210	ug/L	0.0E+00	(mg/kg/day)	7.3E-03	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(b)fluoranthene	0.450	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(k)fluoranthene	2.00	ug/L	0.0E+00	(mg/kg/day)	7.3E-02	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(a)pyrene	0.620	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Dibenzo(a,h)anthracene	0.500	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(g,h,i)perylene	0.620	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
			Exp. Route Total								1.3E-08					0.04
		Exposure Point Total									1.3E-08					0.04
	Exposure Medium Total										1.3E-08					0.04

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Construction Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Air	Site 23	Inhalation	Aluminum	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	1.4E-03	(mg/kg/day)	–
				Antimony	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Arsenic	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	1.5E+01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Barium	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	1.4E-04	(mg/kg/day)	–
				Beryllium	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	8.4E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	5.7E-06	(mg/kg/day)	–
				Chromium	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	4.2E+01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	2.9E-05	(mg/kg/day)	–
				Cobalt	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Copper	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Iron	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Manganese	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	1.4E-05	(mg/kg/day)	–
				Selenium	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Silver	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Zinc	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Tetrachloroethene	1.4E-5	mg/m3	2.4E-09	(mg/kg/day)	2.0E-02	(mg/kg/day)$^{-1}$	4.8E-11	1.7E-07	(mg/kg/day)	8.0E-02	(mg/kg/day)	0.000002
				Dimethylphthalate	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Diethylphthalate	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Di-n-butylphthalate	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Bis(2-Ethylhexyl)phthalate	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Naphthalene	1.1E-5	mg/m3	1.8E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.3E-07	(mg/kg/day)	8.6E-04	(mg/kg/day)	0.0001
				Phenanthrene	1.5E-5	mg/m3	2.6E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.8E-07	(mg/kg/day)	NA	(mg/kg/day)	–
				Fluoranthene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Pyrene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(a)anthracene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Chrysene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(b)fluoranthene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(k)fluoranthene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(a)pyrene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	3.1E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Dibenzo(a,h)anthracene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(g,h,i)perylene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
			Exp. Route Total								4.8E-11					0.0002
		Exposure Point Total									4.8E-11					0.0002
	Exposure Medium Total										4.8E-11					0.0002
Medium Total											1.3E-08					0.04
										Total of Receptor Risks Across All Media	1.3E-08				Total of Receptor Hazards Across All Media	0.04

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Site 23	Ingestion	Aluminum	2540	ug/L	2.1E-02	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	2.4E-01	(mg/kg/day)	1.0E+00	(mg/kg/day)	0.2
				Antimony	3.20	ug/L	2.6E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.1E-04	(mg/kg/day)	4.0E-04	(mg/kg/day)	0.8
				Arsenic	9.10	ug/L	7.5E-05	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	1.1E-04	8.7E-04	(mg/kg/day)	3.0E-04	(mg/kg/day)	2.9
				Barium	96.7	ug/L	7.9E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	9.3E-03	(mg/kg/day)	2.0E-01	(mg/kg/day)	0.05
				Beryllium	0.980	ug/L	8.1E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	9.4E-05	(mg/kg/day)	2.0E-03	(mg/kg/day)	0.05
				Chromium	6.50	ug/L	5.3E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	6.2E-04	(mg/kg/day)	3.0E-03	(mg/kg/day)	0.2
				Cobalt	4.40	ug/L	3.6E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	4.2E-04	(mg/kg/day)	NA	(mg/kg/day)	--
				Copper	10.6	ug/L	8.7E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.0E-03	(mg/kg/day)	4.0E-02	(mg/kg/day)	0.03
				Iron	62500	ug/L	5.1E-01	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	6.0E+00	(mg/kg/day)	7.0E-01	(mg/kg/day)	8.6
				Manganese	1630	ug/L	1.3E-02	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.6E-01	(mg/kg/day)	2.4E-02	(mg/kg/day)	6.5
				Selenium	5.40	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	5.2E-04	(mg/kg/day)	5.0E-03	(mg/kg/day)	0.1
				Silver	1.90	ug/L	1.6E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.8E-04	(mg/kg/day)	5.0E-03	(mg/kg/day)	0.04
				Zinc	87.9	ug/L	7.2E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	8.4E-03	(mg/kg/day)	3.0E-01	(mg/kg/day)	0.03
				Tetrachloroethene	0.500	ug/L	4.1E-06	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	2.2E-06	4.8E-05	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.005
				Dimethylphthalate	1.10	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.1E-04	(mg/kg/day)	NA	(mg/kg/day)	--
				Diethylphthalate	20.0	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.9E-03	(mg/kg/day)	8.0E-01	(mg/kg/day)	0.002
				Di-n-butylphthalate	10.0	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	9.6E-04	(mg/kg/day)	1.0E-01	(mg/kg/day)	0.010
				Bis(2-Ethylhexyl)phthalate	20.0	ug/L	1.6E-04	(mg/kg/day)	1.4E-02	(mg/kg/day)$^{-1}$	2.3E-06	1.9E-03	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.10
				Naphthalene	0.370	ug/L	3.0E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.5E-05	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.002
				Phenanthrene	0.580	ug/L	4.8E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	5.6E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Fluoranthene	0.580	ug/L	4.8E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	5.6E-05	(mg/kg/day)	4.0E-02	(mg/kg/day)	0.001
				Pyrene	0.520	ug/L	4.3E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	5.0E-05	(mg/kg/day)	3.0E-02	(mg/kg/day)	0.002
				Benzo(a)anthracene	0.250	ug/L	1.1E-05	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	8.0E-06	2.4E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Chrysene	0.210	ug/L	1.7E-06	(mg/kg/day)	7.3E-03	(mg/kg/day)$^{-1}$	1.3E-08	2.0E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.450	ug/L	2.0E-05	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	1.4E-05	4.3E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	2.00	ug/L	8.8E-05	(mg/kg/day)	7.3E-02	(mg/kg/day)$^{-1}$	6.4E-06	1.9E-04	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)pyrene	0.620	ug/L	2.7E-05	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	2.0E-04	5.9E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Dibenzo(a,h)anthracene	0.500	ug/L	2.2E-05	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	1.6E-04	4.8E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(g,h,i)perylene	0.620	ug/L	5.1E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	5.9E-05	(mg/kg/day)	NA	(mg/kg/day)	--
			Exp. Route Total								5.0E-04					20
			Dermal	Aluminum	2540	ug/L	7.7E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	2.7E-04	(mg/kg/day)	1.0E+00	(mg/kg/day)	0.0003
				Antimony	3.20	ug/L	9.6E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.4E-07	(mg/kg/day)	6.0E-05	(mg/kg/day)	0.006
				Arsenic	9.10	ug/L	2.7E-08	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	4.1E-08	9.6E-07	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.003
				Barium	96.7	ug/L	2.9E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.0E-05	(mg/kg/day)	1.4E-02	(mg/kg/day)	0.0007
				Beryllium	0.980	ug/L	3.0E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.0E-07	(mg/kg/day)	1.4E-05	(mg/kg/day)	0.007
				Chromium	6.50	ug/L	3.9E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.4E-06	(mg/kg/day)	7.5E-05	(mg/kg/day)	0.02
				Cobalt	4.40	ug/L	1.3E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	4.6E-07	(mg/kg/day)	NA	(mg/kg/day)	--
				Copper	10.6	ug/L	3.2E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.1E-06	(mg/kg/day)	4.0E-02	(mg/kg/day)	0.00003
				Iron	62500	ug/L	1.9E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	6.6E-03	(mg/kg/day)	7.0E-01	(mg/kg/day)	0.009
				Manganese	1630	ug/L	4.9E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.7E-04	(mg/kg/day)	9.6E-04	(mg/kg/day)	0.2
				Selenium	5.40	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	5.7E-07	(mg/kg/day)	5.0E-03	(mg/kg/day)	0.0001
				Silver	1.90	ug/L	3.4E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.2E-07	(mg/kg/day)	2.0E-04	(mg/kg/day)	0.0006
				Zinc	87.9	ug/L	1.6E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	5.6E-06	(mg/kg/day)	3.0E-01	(mg/kg/day)	0.00002
				Tetrachloroethene	0.500	ug/L	2.7E-07	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	1.4E-07	9.3E-06	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.0009
				Dimethylphthalate	1.10	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.0E-06	(mg/kg/day)	NA	(mg/kg/day)	--
				Diethylphthalate	20.0	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	6.2E-05	(mg/kg/day)	8.0E-01	(mg/kg/day)	0.00008
				Di-n-butylphthalate	10.0	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	2.5E-04	(mg/kg/day)	1.0E-01	(mg/kg/day)	0.002
				Bis(2-Ethylhexyl)phthalate	20.0	ug/L	2.7E-05	(mg/kg/day)	1.4E-02	(mg/kg/day)$^{-1}$	3.8E-07	9.5E-04	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.05
				Naphthalene	0.370	ug/L	2.1E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	7.5E-06	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.0004
				Phenanthrene	0.580	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Fluoranthene	0.580	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	4.0E-02	(mg/kg/day)	--
				Pyrene	0.520	ug/L	2.0E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	7.0E-05	(mg/kg/day)	3.0E-02	(mg/kg/day)	0.002
				Benzo(a)anthracene	0.250	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Chrysene	0.210	ug/L	0.0E+00	(mg/kg/day)	7.3E-03	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.450	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Site 23	Dermal	Benzo(k)fluoranthene	2.00	ug/L	0.0E+00	(mg/kg/day)	7.3E-02	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(a)pyrene	0.620	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Dibenzo(a,h)anthracene	0.500	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(g,h,i)perylene	0.620	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
			Exp. Route Total								5.6E-07					0.3
		Exposure Point Total									5.0E-04					20
	Exposure Medium Total										5.0E-04					20
Groundwater	Air	Site 23	Inhalation	Aluminum	2540	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	1.0E+00	(mg/kg/day)	–
				Antimony	3.20	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	4.0E-04	(mg/kg/day)	–
				Arsenic	9.10	ug/L	0.0E+00	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	3.0E-04	(mg/kg/day)	–
				Barium	96.7	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	2.0E-01	(mg/kg/day)	–
				Beryllium	0.980	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	2.0E-03	(mg/kg/day)	–
				Chromium	6.50	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	3.0E-03	(mg/kg/day)	–
				Cobalt	4.40	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Copper	10.6	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	4.0E-02	(mg/kg/day)	–
				Iron	62500	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	7.0E-01	(mg/kg/day)	–
				Manganese	1630	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	2.4E-02	(mg/kg/day)	–
				Selenium	5.40	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	5.0E-03	(mg/kg/day)	--
				Silver	1.90	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	5.0E-03	(mg/kg/day)	--
				Zinc	87.9	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	3.0E-01	(mg/kg/day)	–
				Tetrachloroethene	0.500	ug/L	4.1E-06	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	2.2E-06	4.8E-05	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.005
				Dimethylphthalate	1.10	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Diethylphthalate	20.0	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	8.0E-01	(mg/kg/day)	–
				Di-n-butylphthalate	10.0	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	1.0E-01	(mg/kg/day)	–
				Bis(2-Ethylhexyl)phthalate	20.0	ug/L	0.0E+00	(mg/kg/day)	1.4E-02	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	2.0E-02	(mg/kg/day)	–
				Naphthalene	0.370	ug/L	3.0E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.5E-05	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.002
				Phenanthrene	0.580	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Fluoranthene	0.580	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	4.0E-02	(mg/kg/day)	–
				Pyrene	0.520	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	3.0E-02	(mg/kg/day)	–
				Benzo(a)anthracene	0.250	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Chrysene	0.210	ug/L	0.0E+00	(mg/kg/day)	7.3E-03	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(b)fluoranthene	0.450	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	2.00	ug/L	0.0E+00	(mg/kg/day)	7.3E-02	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(a)pyrene	0.620	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Dibenzo(a,h)anthracene	0.500	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(g,h,i)perylene	0.620	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
			Exp. Route Total								2.2E-06					0.007
		Exposure Point Total									2.2E-06					0.007
	Exposure Medium Total										2.2E-06					0.007
Medium Total											5.1E-04					20
										Total of Receptor Risks Across All Media	5.1E-04				Total of Receptor Hazards Across All Media	20

Note:
Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Site 23	Ingestion	Aluminum	2540	ug/L	2.0E-02	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.7E-01	(mg/kg/day)	1.0E+00	(mg/kg/day)	0.2
				Antimony	3.20	ug/L	2.5E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	2.1E-04	(mg/kg/day)	4.0E-04	(mg/kg/day)	0.5
				Arsenic	9.10	ug/L	7.1E-05	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	1.1E-04	6.0E-04	(mg/kg/day)	3.0E-04	(mg/kg/day)	2.0
				Barium	96.7	ug/L	7.6E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	6.4E-03	(mg/kg/day)	2.0E-01	(mg/kg/day)	0.03
				Beryllium	0.980	ug/L	7.7E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	6.4E-05	(mg/kg/day)	2.0E-03	(mg/kg/day)	0.03
				Chromium	6.50	ug/L	5.1E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	4.3E-04	(mg/kg/day)	3.0E-03	(mg/kg/day)	0.1
				Cobalt	4.40	ug/L	3.4E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	2.9E-04	(mg/kg/day)	NA	(mg/kg/day)	--
				Copper	10.6	ug/L	8.3E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	7.0E-04	(mg/kg/day)	4.0E-02	(mg/kg/day)	0.02
				Iron	62500	ug/L	4.9E-01	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	4.1E+00	(mg/kg/day)	7.0E-01	(mg/kg/day)	5.9
				Manganese	1630	ug/L	1.3E-02	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.1E-01	(mg/kg/day)	2.4E-02	(mg/kg/day)	4.5
				Selenium	5.40	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.6E-04	(mg/kg/day)	5.0E-03	(mg/kg/day)	0.07
				Silver	1.90	ug/L	1.5E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.2E-04	(mg/kg/day)	5.0E-03	(mg/kg/day)	0.02
				Zinc	87.9	ug/L	6.9E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	5.8E-03	(mg/kg/day)	3.0E-01	(mg/kg/day)	0.02
				Tetrachloroethene	0.500	ug/L	3.9E-06	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	2.1E-06	3.3E-05	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.003
				Dimethylphthalate	1.10	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	7.2E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Diethylphthalate	20.0	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.3E-03	(mg/kg/day)	8.0E-01	(mg/kg/day)	0.002
				Di-n-butylphthalate	10.0	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	6.6E-04	(mg/kg/day)	1.0E-01	(mg/kg/day)	0.007
				Bis(2-Ethylhexyl)phthalate	20.0	ug/L	1.6E-04	(mg/kg/day)	1.4E-02	(mg/kg/day)$^{-1}$	2.2E-06	1.3E-03	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.07
				Naphthalene	0.370	ug/L	2.9E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	2.4E-05	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.001
				Phenanthrene	0.580	ug/L	4.5E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.8E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Fluoranthene	0.580	ug/L	4.5E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.8E-05	(mg/kg/day)	4.0E-02	(mg/kg/day)	0.0010
				Pyrene	0.520	ug/L	4.1E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.4E-05	(mg/kg/day)	3.0E-02	(mg/kg/day)	0.001
				Benzo(a)anthracene	0.250	ug/L	3.9E-06	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	2.9E-06	1.6E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Chrysene	0.210	ug/L	1.6E-06	(mg/kg/day)	7.3E-03	(mg/kg/day)$^{-1}$	1.2E-08	1.4E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.450	ug/L	7.0E-06	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	5.1E-06	3.0E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	2.00	ug/L	3.1E-05	(mg/kg/day)	7.3E-02	(mg/kg/day)$^{-1}$	2.3E-06	1.3E-04	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)pyrene	0.620	ug/L	9.7E-06	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	7.1E-05	4.1E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Dibenzo(a,h)anthracene	0.500	ug/L	7.8E-06	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	5.7E-05	3.3E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(g,h,i)perylene	0.620	ug/L	4.9E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	4.1E-05	(mg/kg/day)	NA	(mg/kg/day)	--
			Exp. Route Total								2.5E-04					13
			Dermal	Aluminum	2540	ug/L	5.4E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.8E-04	(mg/kg/day)	1.0E+00	(mg/kg/day)	0.0004
				Antimony	3.20	ug/L	6.8E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	4.7E-07	(mg/kg/day)	6.0E-05	(mg/kg/day)	0.008
				Arsenic	9.10	ug/L	1.9E-07	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	2.9E-07	1.3E-06	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.004
				Barium	96.7	ug/L	2.0E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.4E-05	(mg/kg/day)	1.4E-02	(mg/kg/day)	0.001
				Beryllium	0.980	ug/L	2.1E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.4E-07	(mg/kg/day)	1.4E-05	(mg/kg/day)	0.01
				Chromium	6.50	ug/L	2.7E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.9E-06	(mg/kg/day)	7.5E-05	(mg/kg/day)	0.03
				Cobalt	4.40	ug/L	9.3E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	6.5E-07	(mg/kg/day)	NA	(mg/kg/day)	--
				Copper	10.6	ug/L	2.2E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.6E-06	(mg/kg/day)	4.0E-02	(mg/kg/day)	0.00004
				Iron	62500	ug/L	1.3E-03	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	9.2E-03	(mg/kg/day)	7.0E-01	(mg/kg/day)	0.01
				Manganese	1630	ug/L	3.4E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	2.4E-04	(mg/kg/day)	9.6E-04	(mg/kg/day)	0.3
				Selenium	5.40	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	8.0E-07	(mg/kg/day)	5.0E-03	(mg/kg/day)	0.0002
				Silver	1.90	ug/L	2.4E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.7E-07	(mg/kg/day)	2.0E-04	(mg/kg/day)	0.0008
				Zinc	87.9	ug/L	1.1E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	7.8E-06	(mg/kg/day)	3.0E-01	(mg/kg/day)	0.00003
				Tetrachloroethene	0.500	ug/L	1.9E-06	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	1.0E-06	1.3E-05	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.001
				Dimethylphthalate	1.10	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.4E-06	(mg/kg/day)	NA	(mg/kg/day)	--
				Diethylphthalate	20.0	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	8.7E-05	(mg/kg/day)	8.0E-01	(mg/kg/day)	0.0001
				Di-n-butylphthalate	10.0	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.5E-04	(mg/kg/day)	1.0E-01	(mg/kg/day)	0.003
				Bis(2-Ethylhexyl)phthalate	20.0	ug/L	1.9E-04	(mg/kg/day)	1.4E-02	(mg/kg/day)$^{-1}$	2.7E-06	1.3E-03	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.07
				Naphthalene	0.370	ug/L	1.5E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.1E-05	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.0005
				Phenanthrene	0.580	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Fluoranthene	0.580	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	4.0E-02	(mg/kg/day)	--
				Pyrene	0.520	ug/L	1.4E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	9.9E-05	(mg/kg/day)	3.0E-02	(mg/kg/day)	0.003
				Benzo(a)anthracene	0.250	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Chrysene	0.210	ug/L	0.0E+00	(mg/kg/day)	7.3E-03	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.450	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Site 23	Dermal	Benzo(k)fluoranthene	2.00	ug/L	0.0E+00	(mg/kg/day)	7.3E-02	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(a)pyrene	0.620	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Dibenzo(a,h)anthracene	0.500	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(g,h,i)perylene	0.620	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
			Exp. Route Total								4.0E-06					0.4
		Exposure Point Total									2.5E-04					14
	Exposure Medium Total										2.5E-04					14
Groundwater	Air	Site 23	Inhalation	Aluminum	2540	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	1.0E+00	(mg/kg/day)	–
				Antimony	3.20	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	4.0E-04	(mg/kg/day)	–
				Arsenic	9.10	ug/L	0.0E+00	(mg/kg/day)	1.5E+00	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	3.0E-04	(mg/kg/day)	–
				Barium	96.7	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	2.0E-01	(mg/kg/day)	–
				Beryllium	0.980	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	2.0E-03	(mg/kg/day)	–
				Chromium	6.50	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	3.0E-03	(mg/kg/day)	–
				Cobalt	4.40	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Copper	10.6	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	4.0E-02	(mg/kg/day)	–
				Iron	62500	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	7.0E-01	(mg/kg/day)	–
				Manganese	1630	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	2.4E-02	(mg/kg/day)	–
				Selenium	5.40	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	5.0E-03	(mg/kg/day)	–
				Silver	1.90	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	5.0E-03	(mg/kg/day)	–
				Zinc	87.9	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	3.0E-01	(mg/kg/day)	–
				Tetrachloroethene	0.500	ug/L	3.9E-06	(mg/kg/day)	5.4E-01	$(mg/kg/day)^{-1}$	2.1E-06	3.3E-05	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.003
				Dimethylphthalate	1.10	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Diethylphthalate	20.0	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	8.0E-01	(mg/kg/day)	–
				Di-n-butylphthalate	10.0	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	1.0E-01	(mg/kg/day)	–
				Bis(2-Ethylhexyl)phthalate	20.0	ug/L	0.0E+00	(mg/kg/day)	1.4E-02	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	2.0E-02	(mg/kg/day)	–
				Naphthalene	0.370	ug/L	2.9E-06	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	2.4E-05	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.001
				Phenanthrene	0.580	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Fluoranthene	0.580	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	4.0E-02	(mg/kg/day)	–
				Pyrene	0.520	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	3.0E-02	(mg/kg/day)	–
				Benzo(a)anthracene	0.250	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Chrysene	0.210	ug/L	0.0E+00	(mg/kg/day)	7.3E-03	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(b)fluoranthene	0.450	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(k)fluoranthene	2.00	ug/L	0.0E+00	(mg/kg/day)	7.3E-02	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(a)pyrene	0.620	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Dibenzo(a,h)anthracene	0.500	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
				Benzo(g,h,i)perylene	0.620	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	–
			Exp. Route Total								2.1E-06					0.005
		Exposure Point Total									2.1E-06					0.005
	Exposure Medium Total										2.1E-06					0.005
Medium Total											2.6E-04					14
										Total of Receptor Risks Across All Media	2.6E-04				Total of Receptor Hazards Across All Media	14

Note:
Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.

5/15/2008

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Construction Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 23	Aluminum	--	–	--	–	--	CNS	–	--	0.00004	0.00004
			Antimony	--	–	--	–	--	Blood	–	--	0.0008	0.0008
			Arsenic	--	–	3E-09	–	3E-09	Skin, CVS	–	--	0.0005	0.0005
			Barium	--	–	--	–	--	Kidney	–	--	0.0001	0.0001
			Beryllium	--	–	--	–	--	GS	–	--	0.001	0.001
			Chromium	--	–	--	–	--	Fetotoxicity, GS, Bone	–	--	0.003	0.003
			Cobalt	--	–	--	–	--	NA	–	--	–	–
			Copper	--	–	--	–	--	GS	–	--	0.000004	0.000004
			Iron	--	–	--	–	--	GS	–	--	0.001	0.001
			Manganese	--	–	--	–	--	CNS	–	--	0.03	0.03
			Selenium	--	–	--	–	--	Skin	–	--	0.00002	0.00002
			Silver	--	–	--	–	--	Skin	–	--	0.00009	0.00009
			Zinc	--	–	--	–	--	Blood	–	--	0.000003	0.000003
			Tetrachloroethene	--	–	3E-09	–	3E-09	Liver	–	--	0.00004	0.00004
			Dimethylphthalate	--	–	--	–	--	NA	–	--	–	–
			Diethylphthalate	--	–	--	–	--	Body Weight	–	--	0.000003	0.000003
			Di-n-butylphthalate	--	–	--	–	--	Mortality	–	--	0.00009	0.00009
			Bis(2-Ethylhexyl)phthalate	--	–	7E-09	–	7E-09	Liver	–	--	0.002	0.002
			Naphthalene	--	–	--	–	--	Body Weight	–	--	0.00002	0.00002
			Phenanthrene	--	–	--	–	--	Kidney	–	--	–	–
			Fluoranthene	--	–	--	–	--	Liver	–	--	–	–
			Pyrene	--	–	--	–	--	Kidney	–	--	0.00009	0.00009
			Benzo(a)anthracene	--	–	--	–	--	NA	–	--	–	–
			Chrysene	--	–	--	–	--	NA	–	--	–	–
			Benzo(b)fluoranthene	--	–	--	–	--	NA	–	--	–	–
			Benzo(k)fluoranthene	--	–	--	–	--	NA	–	--	–	–
			Benzo(a)pyrene	--	–	--	–	--	NA	–	--	–	–
			Dibenzo(a,h)anthracene	--	–	--	–	--	NA	–	--	–	–
			Benzo(g,h,i)perylene	--	–	--	–	--	Kidney	–	--	–	–
			Chemical Total	--	–	1E-08	–	1E-08		–	--	0.04	0.04
		Exposure Point Total						1E-08					0.04
	Exposure Medium Total							1E-08					0.04

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Construction Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 23	Aluminum	–	--	–	–	--	CNS	--	–	--	–
			Antimony	–	--	–	–	--	NA	--	–	--	–
			Arsenic	–	--	–	–	--	NA	--	–	--	–
			Barium	–	--	–	–	--	Fetotoxicity	--	–	--	–
			Beryllium	–	--	–	–	--	GS	--	–	--	–
			Chromium	–	--	–	–	--	Lungs	--	–	--	–
			Cobalt	–	--	–	–	--	NA	--	–	--	–
			Copper	–	--	–	–	--	NA	--	–	--	–
			Iron	–	--	–	–	--	NA	--	–	--	–
			Manganese	–	--	–	–	--	CNS	--	–	--	–
			Selenium	–	--	–	–	--	NA	--	–	--	–
			Silver	–	--	–	–	--	NA	--	–	--	–
			Zinc	–	--	–	–	--	NA	--	–	--	–
			Tetrachloroethene	–	5E-11	–	–	5E-11	Liver	--	0.000002	--	0.000002
			Dimethylphthalate	–	--	–	–	--	NA	--	–	--	–
			Diethylphthalate	–	--	–	–	--	NA	--	–	--	–
			Di-n-butylphthalate	–	--	–	–	--	NA	--	–	--	–
			Bis(2-Ethylhexyl)phthalate	–	--	–	–	--	NA	--	–	--	–
			Naphthalene	–	--	–	–	--	Nasal	--	0.0001	--	0.0001
			Phenanthrene	–	--	–	–	--	NA	--	–	--	–
			Fluoranthene	–	--	–	–	--	NA	--	–	--	–
			Pyrene	–	--	–	–	--	NA	--	–	--	–
			Benzo(a)anthracene	–	--	–	–	--	NA	--	–	--	–
			Chrysene	–	--	–	–	--	NA	--	–	--	–
			Benzo(b)fluoranthene	–	--	–	–	--	NA	--	–	--	–
			Benzo(k)fluoranthene	–	--	–	–	--	NA	--	–	--	–
			Benzo(a)pyrene	–	--	–	–	--	NA	--	–	--	–
			Dibenzo(a,h)anthracene	–	--	–	–	--	NA	--	–	--	–
			Benzo(g,h,i)perylene	–	--	–	–	--	NA	--	–	--	–
			Chemical Total	–	5E-11	–	–	5E-11		--	0.0002	--	0.0002
		Exposure Point Total						5E-11					0.0002
	Exposure Medium Total							5E-11					0.0002
Medium Total								1E-08					0.04
Receptor Total							Receptor Risk Total	1E-08				Receptor HI Total	0.04

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TABLE 9.2.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 23	Aluminum	--	–	--	–	--	CNS	0.2	--	0.0003	0.2
			Antimony	--	–	--	–	--	Blood	0.8	--	0.006	0.8
			Arsenic	1E-04	–	4E-08	–	1E-04	Skin, CVS	3	--	0.003	3
			Barium	--	–	--	–	--	Kidney	0.05	--	0.0007	0.05
			Beryllium	--	–	--	–	--	GS	0.05	--	0.007	0.05
			Chromium	--	–	--	–	--	Fetotoxicity, GS, Bone	0.2	--	0.02	0.2
			Cobalt	--	–	--	–	--	NA	–	--	–	–
			Copper	--	–	--	–	--	GS	0.03	--	0.00003	0.03
			Iron	--	–	--	–	--	GS	9	--	0.009	9
			Manganese	--	–	--	–	--	CNS	7	--	0.2	7
			Selenium	--	–	--	–	--	Skin	0.1	--	0.0001	0.1
			Silver	--	–	--	–	--	Skin	0.04	--	0.0006	0.04
			Zinc	--	–	--	–	--	Blood	0.03	--	0.00002	0.03
			Tetrachloroethene	2E-06	–	1E-07	–	2E-06	Liver	0.005	--	0.0009	0.006
			Dimethylphthalate	--	–	--	–	--	NA	–	--	–	–
			Diethylphthalate	--	–	--	–	--	Body Weight	0.002	--	0.00008	0.002
			Di-n-butylphthalate	--	–	--	–	--	Mortality	0.010	--	0.002	0.01
			Bis(2-Ethylhexyl)phthalate	2E-06	–	4E-07	–	3E-06	Liver	0.10	--	0.05	0.1
			Naphthalene	--	–	--	–	--	Body Weight	0.002	--	0.0004	0.002
			Phenanthrene	--	–	--	–	--	Kidney	–	--	–	–
			Fluoranthene	--	–	--	–	--	Liver	0.001	--	–	0.001
			Pyrene	--	–	--	–	--	Kidney	0.002	--	0.002	0.004
			Benzo(a)anthracene	8E-06	–	--	–	8E-06	NA	–	--	–	–
			Chrysene	1E-08	–	--	–	1E-08	NA	–	--	–	–
			Benzo(b)fluoranthene	1E-05	–	--	–	1E-05	NA	–	--	–	–
			Benzo(k)fluoranthene	6E-06	–	--	–	6E-06	NA	–	--	–	–
			Benzo(a)pyrene	2E-04	–	--	–	2E-04	NA	–	--	–	–
			Dibenzo(a,h)anthracene	2E-04	–	--	–	2E-04	NA	–	--	–	–
			Benzo(g,h,i)perylene	--	–	--	–	--	Kidney	–	--	–	–
			Chemical Total	5E-04	–	6E-07	–	5E-04		20	--	0.3	20
		Exposure Point Total						5E-04					20
	Exposure Medium Total							5E-04					20

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 23	Aluminum	–	--	–	–	--	CNS	--	–	--	–
			Antimony	–	--	–	–	--	NA	--	–	--	–
			Arsenic	–	--	–	–	--	NA	--	–	--	–
			Barium	–	--	–	–	--	Fetotoxicity	--	–	--	–
			Beryllium	–	--	–	–	--	GS	--	–	--	–
			Chromium	–	--	–	–	--	Lungs	--	–	--	–
			Cobalt	–	--	–	–	--	NA	--	–	--	–
			Copper	–	--	–	–	--	NA	--	–	--	–
			Iron	–	--	–	–	--	NA	--	–	--	–
			Manganese	–	--	–	–	--	CNS	--	–	--	–
			Selenium	–	--	–	–	--	NA	--	–	--	–
			Silver	–	--	–	–	--	NA	--	–	--	–
			Zinc	–	--	–	–	--	NA	--	–	--	–
			Tetrachloroethene	–	2E-06	–	–	2E-06	Liver	--	0.005	--	0.005
			Dimethylphthalate	–	--	–	–	--	NA	--	–	--	–
			Diethylphthalate	–	--	–	–	--	NA	--	–	--	–
			Di-n-butylphthalate	–	--	–	–	--	NA	--	–	--	–
			Bis(2-Ethylhexyl)phthalate	–	--	–	–	--	NA	--	–	--	–
			Naphthalene	–	--	–	–	--	Nasal	--	0.002	--	0.002
			Phenanthrene	–	--	–	–	--	NA	--	–	--	–
			Fluoranthene	–	--	–	–	--	NA	--	–	--	–
			Pyrene	–	--	–	–	--	NA	--	–	--	–
			Benzo(a)anthracene	–	--	–	–	--	NA	--	–	--	–
			Chrysene	–	--	–	–	--	NA	--	–	--	–
			Benzo(b)fluoranthene	–	--	–	–	--	NA	--	–	--	–
			Benzo(k)fluoranthene	–	--	–	–	--	NA	--	–	--	–
			Benzo(a)pyrene	–	--	–	–	--	NA	--	–	--	–
			Dibenzo(a,h)anthracene	–	--	–	–	--	NA	--	–	--	–
			Benzo(g,h,i)perylene	–	--	–	–	--	NA	--	–	--	–
			Chemical Total	–	2E-06	–	–	2E-06		--	0.007	--	0.007
		Exposure Point Total						2E-06					0.007
	Exposure Medium Total							2E-06					0.007
Medium Total								5E-04					20
Receptor Total							Receptor Risk Total	5E-04				Receptor HI Total	20

Note:

Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Total Body Weight HI	0.005
Total CNS HI	7
Total CVS HI	3
Total GS HI	9
Total Kidney HI	0.05
Total Liver HI	0.2
Total Skin HI	3
Total Nasal HI	0.002
Total Bone HI	0.2
Total Fetotoxicity HI	0.2
Total Mortality HI	0.01

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 23	Aluminum	--	–	--	–	--	CNS	0.2	--	0.0004	0.2
			Antimony	--	–	--	–	--	Blood	0.5	--	0.008	0.5
			Arsenic	1E-04	–	3E-07	–	1E-04	Skin, CVS	2	--	0.004	2
			Barium	--	–	--	–	--	Kidney	0.03	--	0.001	0.03
			Beryllium	--	–	--	–	--	GS	0.03	--	0.01	0.04
			Chromium	--	–	--	–	--	Fetotoxicity, GS, Bone	0.1	--	0.03	0.2
			Cobalt	--	–	--	–	--	NA	–	--	–	–
			Copper	--	–	--	–	--	GS	0.02	--	0.00004	0.02
			Iron	--	–	--	–	--	GS	6	--	0.01	6
			Manganese	--	–	--	–	--	CNS	4	--	0.3	5
			Selenium	--	–	--	–	--	Skin	0.07	--	0.0002	0.07
			Silver	--	–	--	–	--	Skin	0.02	--	0.0008	0.03
			Zinc	--	–	--	–	--	Blood	0.02	--	0.00003	0.02
			Tetrachloroethene	2E-06	–	1E-06	–	3E-06	Liver	0.003	--	0.001	0.005
			Dimethylphthalate	--	–	--	–	--	NA	–	--	–	–
			Diethylphthalate	--	–	--	–	--	Body Weight	0.002	--	0.0001	0.002
			Di-n-butylphthalate	--	–	--	–	--	Mortality	0.007	--	0.003	0.01
			Bis(2-Ethylhexyl)phthalate	2E-06	–	3E-06	–	5E-06	Liver	0.07	--	0.07	0.1
			Naphthalene	--	–	--	–	--	Body Weight	0.001	--	0.0005	0.002
			Phenanthrene	--	–	--	–	--	Kidney	–	--	–	–
			Fluoranthene	--	–	--	–	--	Liver	0.0010	--	–	0.0010
			Pyrene	--	–	--	–	--	Kidney	0.001	--	0.003	0.004
			Benzo(a)anthracene	3E-06	–	--	–	3E-06	NA	–	--	–	–
			Chrysene	1E-08	–	--	–	1E-08	NA	–	--	–	–
			Benzo(b)fluoranthene	5E-06	–	--	–	5E-06	NA	–	--	–	–
			Benzo(k)fluoranthene	2E-06	–	--	–	2E-06	NA	–	--	–	–
			Benzo(a)pyrene	7E-05	–	--	–	7E-05	NA	–	--	–	–
			Dibenzo(a,h)anthracene	6E-05	–	--	–	6E-05	NA	–	--	–	–
			Benzo(g,h,i)perylene	--	–	--	–	--	Kidney	–	--	–	–
			Chemical Total	2E-04	–	4E-06	–	3E-04		13	--	0.4	14
		Exposure Point Total						3E-04					14
	Exposure Medium Total							3E-04					14

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 23	Aluminum	–	--	–	–	--	CNS	--	–	--	–
			Antimony	–	--	–	–	--	NA	--	–	--	–
			Arsenic	–	--	–	–	--	NA	--	–	--	–
			Barium	–	--	–	–	--	Fetotoxicity	--	–	--	–
			Beryllium	–	--	–	–	--	GS	--	–	--	–
			Chromium	–	--	–	–	--	Lungs	--	–	--	–
			Cobalt	–	--	–	–	--	NA	--	–	--	–
			Copper	–	--	–	–	--	NA	--	–	--	–
			Iron	–	--	–	–	--	NA	--	–	--	–
			Manganese	–	--	–	–	--	CNS	--	–	--	–
			Selenium	–	--	–	–	--	NA	--	–	--	–
			Silver	–	--	–	–	--	NA	--	–	--	–
			Zinc	–	--	–	–	--	NA	--	–	--	–
			Tetrachloroethene	–	2E-06	–	–	2E-06	Liver	--	0.003	--	0.003
			Dimethylphthalate	–	--	–	–	--	NA	--	–	--	–
			Diethylphthalate	–	--	–	–	--	NA	--	–	--	–
			Di-n-butylphthalate	–	--	–	–	--	NA	--	–	--	–
			Bis(2-Ethylhexyl)phthalate	–	--	–	–	--	NA	--	–	--	–
			Naphthalene	–	--	–	–	--	Nasal	--	0.001	--	0.001
			Phenanthrene	–	--	–	–	--	NA	--	–	--	–
			Fluoranthene	–	--	–	–	--	NA	--	–	--	–
			Pyrene	–	--	–	–	--	NA	--	–	--	–
			Benzo(a)anthracene	–	--	–	–	--	NA	--	–	--	–
			Chrysene	–	--	–	–	--	NA	--	–	--	–
			Benzo(b)fluoranthene	–	--	–	–	--	NA	--	–	--	–
			Benzo(k)fluoranthene	–	--	–	–	--	NA	--	–	--	–
			Benzo(a)pyrene	–	--	–	–	--	NA	--	–	--	–
			Dibenzo(a,h)anthracene	–	--	–	–	--	NA	--	–	--	–
			Benzo(g,h,i)perylene	–	--	–	–	--	NA	--	–	--	–
			Chemical Total	–	2E-06	–	–	2E-06		--	0.005	--	0.005
		Exposure Point Total						2E-06					0.005
	Exposure Medium Total							2E-06					0.005
Medium Total								3E-04					14
Receptor Total							Receptor Risk Total	3E-04				Receptor HI Total	14

Note:

Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.

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TABLE 9.3.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Total Body Weight HI	0.003
Total CNS HI	5
Total CVS HI	2
Total GS HI	6
Total Kidney HI	0.04
Total Liver HI	0.1
Total Skin HI	2
Total Nasal HI	0.001
Total Bone HI	0.2
Total Fetotoxicity HI	0.2
Total Mortality HI	0.01

TABLE 9.4.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Lifelong (Child and Adult)

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 23	Aluminum	--	–	--	–	--					
			Antimony	--	–	--	–	--					
			Arsenic	2E-04	–	3E-07	–	2E-04					
			Barium	--	–	--	–	--					
			Beryllium	--	–	--	–	--					
			Chromium	--	–	--	–	--					
			Cobalt	--	–	--	–	--					
			Copper	--	–	--	–	--					
			Iron	--	–	--	–	--					
			Manganese	--	–	--	–	--					
			Selenium	--	–	--	–	--					
			Silver	--	–	--	–	--					
			Zinc	--	–	--	–	--					
			Tetrachloroethene	4E-06	–	1E-06	–	5E-06					
			Dimethylphthalate	--	–	--	–	--					
			Diethylphthalate	--	–	--	–	--					
			Di-n-butylphthalate	--	–	--	–	--					
			Bis(2-Ethylhexyl)phthalate	4E-06	–	3E-06	–	8E-06					
			Naphthalene	--	–	--	–	--					
			Phenanthrene	--	–	--	–	--					
			Fluoranthene	--	–	--	–	--					
			Pyrene	--	–	--	–	--					
			Benzo(a)anthracene	1E-05	–	--	–	1E-05					
			Chrysene	2E-08	–	--	–	2E-08					
			Benzo(b)fluoranthene	2E-05	–	--	–	2E-05					
			Benzo(k)fluoranthene	9E-06	–	--	–	9E-06					
			Benzo(a)pyrene	3E-04	–	--	–	3E-04					
			Dibenzo(a,h)anthracene	2E-04	–	--	–	2E-04					
			Benzo(g,h,i)perylene	--	–	--	–	--					
			Chemical Total	8E-04	–	5E-06	–	8E-04					
		Exposure Point Total						8E-04					
	Exposure Medium Total							8E-04					

TABLE 9.4.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURES - STORM SEWER REHABILITATION SAMPLING RESULTS

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Lifelong (Child and Adult)

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 23	Aluminum	--	--	--	--	--					
			Antimony	--	--	--	--	--					
			Arsenic	--	--	--	--	--					
			Barium	--	--	--	--	--					
			Beryllium	--	--	--	--	--					
			Chromium	--	--	--	--	--					
			Cobalt	--	--	--	--	--					
			Copper	--	--	--	--	--					
			Iron	--	--	--	--	--					
			Manganese	--	--	--	--	--					
			Selenium	--	--	--	--	--					
			Silver	--	--	--	--	--					
			Zinc	--	--	--	--	--					
			Tetrachloroethene	--	4E-06	--	--	4E-06					
			Dimethylphthalate	--	--	--	--	--					
			Diethylphthalate	--	--	--	--	--					
			Di-n-butylphthalate	--	--	--	--	--					
			Bis(2-Ethylhexyl)phthalate	--	--	--	--	--					
			Naphthalene	--	--	--	--	--					
			Phenanthrene	--	--	--	--	--					
			Fluoranthene	--	--	--	--	--					
			Pyrene	--	--	--	--	--					
			Benzo(a)anthracene	--	--	--	--	--					
			Chrysene	--	--	--	--	--					
			Benzo(b)fluoranthene	--	--	--	--	--					
			Benzo(k)fluoranthene	--	--	--	--	--					
			Benzo(a)pyrene	--	--	--	--	--					
			Dibenzo(a,h)anthracene	--	--	--	--	--					
			Benzo(g,h,i)perylene	--	--	--	--	--					
			Chemical Total	--	4E-06	--	--	4E-06					
		Exposure Point Total						4E-06					
	Exposure Medium Total							4E-06					
Medium Total								8E-04					
Receptor Total							Receptor Risk Total	8E-04					

Note:

Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.

ATTACHMENT A.4

TABLES FROM QUARTERLY UNDERDRAIN METERING PIT SAMPLING

TABLE 3-1

SUMMARY OF POSITIVE DETECTIONS FOR YEAR 1 MONITORING EVENTS
SITE 23 UNDERDRAIN METERING PIT
NSB-NLON, GROTON, CONNECTICUT

PARAMETER	Surface Water Protection Criteria(1)	Residential Volatilization Criteria(2)	Stormwater Discharge Permit Criteria(3)	23MP01 S23GWMPM01 20070618 ORIGINAL	23MP01 FD-061807 20070618 DUPLICATE	23MP01 S23GWMPM02 20070906 ORIGINAL	23MP01 S23GWMPM-03 20071218 ORIGINAL	23MP01 FD-121807-01 20071218 DUPLICATE	23MP01 S23GWMPM-04 20080221 ORIGINAL
Volatile Organics (µg/L)									
BENZENE	710	130	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J
BROMODICHLOROMETHANE	NE	NE	NA	0.3 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
CHLOROFORM	14100	26	NA	3 J	2 J	0.5 U	0.5 U	0.5 U	0.5 U
CYCLOHEXANE	NE	NE	NA	0.5 U	0.5 U	0.1 J	0.5 U	0.5 U	0.5 U
CIS-1,2-DICHLOROETHENE	NE	830	NA	0.3 J	0.2 J	0.3 J	0.2 J	0.5 U	0.2 J
ISOPROPYLBENZENE	NE	2800	NA	0.1 J	0.09 J	0.1 J	0.5 U	0.5 UJ	0.5 U
METHYL TERT-BUTYL ETHER	NE	21000	NA	1	0.9	0.4 J	0.6	0.6	0.7
TETRACHLOROETHENE	88	340	NA	0.3 J	0.3 J	0.4 J	0.3 J	0.2 J	0.3 J
TRICHLOROETHENE	2340	27	NA	0.4 J	0.3 J	0.5 J	0.4 J	0.3 J	0.4 J
PAHs (µg/L)									
1-METHYLNAPHTHALENE	NE	NE	NA	0.2 U	0.2 U	0.2 U	0.96 J	0.048 J	0.21 U
2-METHYLNAPHTHALENE	NE	NE	NA	0.17 J	0.16 J	0.2 U	1.1 J	0.2 UJ	0.21 UJ
4-NITROANILINE	NE	NE	NA	0.2 U	0.2 U	1 UJ	0.75 J	1.0 UR	1.0 UJ
ACENAPHTHENE	NE	NE	NA	0.2 U	0.2 U	0.2 U	0.83 J	0.029 J	0.21 U
ACENAPHTHYLENE	0.3	NE	NA	0.2 U	0.2 U	0.2 U	0.90 J	0.20 UJ	0.21 U
ANTHRACENE	1,100,000	NE	NA	0.2 U	0.2 U	0.2 U	0.92 J	0.20 UJ	0.21 U
BENZO(A)ANTHRACENE	0.3	NE	NA	0.07 U	0.07 U	0.041 U	1.0 J	0.042 UJ	0.045 U
BENZO(A)PYRENE	0.3	NE	NA	0.2 UJ	0.2 U	0.2 U	0.35 J	0.20 U	0.21 U
BENZO(B)FLUORANTHENE	0.3	NE	NA	0.08 U	0.08 U	0.075 U	0.64 J	0.078 UJ	0.082 U
BENZO(G,H,I)PERYLENE	NE	NE	NA	0.2 UJ	0.2 U	0.2 U	0.31	0.20 U	0.21 U
BENZO(K)FLUORANTHENE	0.3	NE	NA	0.2 UJ	0.2 UJ	0.2 U	0.53 J	0.20 U	0.21 U
CHRYSENE	NE	NE	NA	0.2 U	0.2 U	0.2 U	0.76 J	0.20 UJ	0.21 U
DIBENZO(A,H)ANTHRACENE	NE	NE	NA	0.2 UJ	0.2 U	0.2 U	0.14 J	0.20 U	0.21 U
FLUORANTHENE	3,700	NE	NA	0.2 U	0.2 U	0.2 U	1.1 J	0.20 UJ	0.21 U
FLUORENE	140,000	NE	NA	0.2 U	0.2 U	0.2 U	0.97 J	0.20 UJ	0.21 UJ
HEXACHLOROBENZENE	0.077	NE	NA	1 U	1 U	0.2 U	1.2 J	0.20 UJ	0.21 U
HEXACHLOROBUTADIENE	NE	NE	NA	0.2 U	0.2 U	0.48 U	0.64 J	0.099 U	0.21 U
INDENO(1,2,3-CD)PYRENE	NE	NE	NA	0.2 UJ	0.2 U	0.2 U	0.22	0.20 U	0.21 UJ
NAPHTHALENE	NE	NE	NA	0.2 U	0.2 U	0.2 U	1.0 J	0.088 J	0.21 U
PHENANTHRENE	0.3	NE	NA	0.2 U	0.2 U	0.2 U	0.98 J	0.20 UJ	0.21 U
PYRENE	110,000	NE	NA	0.2 U	0.2 U	0.2 U	0.84 J	0.20 UJ	0.21 U
PAHs, Filtered (µg/L)									
1-METHYLNAPHTHALENE	NE	NE	NA	NA	NA	NA	NA	NA	0.093 J
2-METHYLNAPHTHALENE	NE	NE	NA	NA	NA	NA	NA	NA	0.2 UJ
4-NITROANILINE	NE	NE	NA	NA	NA	NA	NA	NA	1.0 UJ
ACENAPHTHENE	NE	NE	NA	NA	NA	NA	NA	NA	0.031 J
ACENAPHTHYLENE	0.3	NE	NA	NA	NA	NA	NA	NA	0.2 U
ANTHRACENE	1,100,000	NE	NA	NA	NA	NA	NA	NA	0.2 U
BENZO(A)ANTHRACENE	0.3	NE	NA	NA	NA	NA	NA	NA	0.042 U

TABLE 3-1

SUMMARY OF POSITIVE DETECTIONS FOR YEAR 1 MONITORING EVENTS
SITE 23 UNDERDRAIN METERING PIT
NSB-NLON, GROTON, CONNECTICUT

PARAMETER	Surface Water Protection Criteria[1]	Residential Volatilization Criteria[2]	Stormwater Discharge Permit Criteria[3]	23MP01 S23GWMPM01 20070618 ORIGINAL	23MP01 FD-061807 20070618 DUPLICATE	23MP01 S23GWMPM02 20070906 ORIGINAL	23MP01 S23GWMPM-03 20071218 ORIGINAL	23MP01 FD-121807-01 20071218 DUPLICATE	23MP01 S23GWMPM-04 20080221 ORIGINAL
PAHs, Filtered (continued) (µg/L)									
BENZO(A)PYRENE	0.3	NE	NA	NA	NA	NA	NA	NA	0.2 U
BENZO(B)FLUORANTHENE	0.3	NE	NA	NA	NA	NA	NA	NA	0.078 U
BENZO(G,H,I)PERYLENE	NE	NE	NA	NA	NA	NA	NA	NA	0.13 J
BENZO(K)FLUORANTHENE	0.3	NE	NA	NA	NA	NA	NA	NA	0.2 U
CHRYSENE	NE	NE	NA	NA	NA	NA	NA	NA	0.2 U
DIBENZO(A,H)ANTHRACENE	NE	NE	NA	NA	NA	NA	NA	NA	0.2 U
FLUORANTHENE	3,700	NE	NA	NA	NA	NA	NA	NA	0.2 U
FLUORENE	140,000	NE	NA	NA	NA	NA	NA	NA	0.2 UJ
HEXACHLOROBENZENE	0.077	NE	NA	NA	NA	NA	NA	NA	0.2 U
HEXACHLOROBUTADIENE	NE	NE	NA	NA	NA	NA	NA	NA	0.2 U
INDENO(1,2,3-CD)PYRENE	NE	NE	NA	NA	NA	NA	NA	NA	0.22 J
NAPHTHALENE	NE	NE	NA	NA	NA	NA	NA	NA	0.069 J
PHENANTHRENE	0.3	NE	NA	NA	NA	NA	NA	NA	0.2 U
PYRENE	110,000	NE	NA	NA	NA	NA	NA	NA	0.2 U
Inorganics, Total (µg/L)									
ALUMINUM	NE	NA	NA	473	115	322	38.1	21.8	29.4
ARSENIC	4	NA	NA	3.7 U	3 U	[redacted]	2.2 U	4.7 U	3.1
BARIUM	NE	NA	NA	48.2	52.4	87	55.2	53.4	55.9
CALCIUM	NUT	NA	NA	33800	35800	32000	35,500	34,700	34,300
CHROMIUM	110 [4]	NA	NA	0.94 U	0.81 U	2	0.41	0.28 U	0.38 U
COBALT	NE	NA	NA	0.84 U	0.64 U	0.26 U	0.66	0.53	0.6
COPPER	48	NA	60	3 U	3 U	4.2	0.44 U	0.22 U	0.8 U
IRON	NUT	NA	NA	9,190	11,900	70,800	9,860	10,200	4,380
LEAD	13	NA	30	2.2	9.3	8.4	2.5 U	2.2 U	1.4 U
MAGNESIUM	NUT	NA	NA	7,260	7660	7,020	7,660	7,490	7,450
MANGANESE	NE	NA	NA	661	715	845	858	815	784
NICKEL	880	NA	NA	1.1 U	0.88 U	0.41 U	0.53	0.46	0.64
POTASSIUM	NUT	NA	NA	5210	5490	5,270	5,590	5,490	5,150
SELENIUM	50	NA	NA	1.5 U	2 J	1.5 U	1.5 U	1.5 U	2.2 U
SILVER	12	NA	NA	0.46 U	0.46 U	1.5	0.46 U	0.46 U	0.54 U
SODIUM	NUT	NA	NA	46,900	49,600	52,100	53,400	52,300	50,100
VANADIUM	NE	NA	NA	1.3 U	1.4 U	3.7	0.34 U	0.29 U	0.52 U
ZINC	123	NA	200	21.3 J	22.3	47.1	22.8	20.0	26.6
Inorganics, Filtered (µg/L)									
ALUMINUM	NE	NA	NA	20.4 J	36.7 J	21.3 J	19.0 U	19.0 U	35.4
ARSENIC	4	NA	NA	3.5 U	2.2 U	1.2 J	1.9 U	1.1 U	2.8
BARIUM	NE	NA	NA	44.6	46.4	50.1	48.9	49.6	56.8
CALCIUM	NUT	NA	NA	33,600	34,700	31,400	33,100	33,400	36,000
CHROMIUM	110 [4]	NA	NA	1.2 U	0.44 U	0.3 J	0.29	0.48	0.38 U
COBALT	NE	NA	NA	0.67 U	0.86 U	0.47 J	0.48	0.51	0.64
IRON	NUT	NA	NA	3,470	3,630	3,600	4,190	4,140	3,750

TABLE 3-1

SUMMARY OF POSITIVE DETECTIONS FOR YEAR 1 MONITORING EVENTS
SITE 23 UNDERDRAIN METERING PIT
NSB-NLON, GROTON, CONNECTICUT

PARAMETER	Surface Water Protection Criteria[1]	Residential Volatilization Criteria[2]	Stormwater Discharge Permit Criteria[3]	23MP01 S23GWMPM01 20070618 ORIGINAL	23MP01 FD-061807 20070618 DUPLICATE	23MP01 S23GWMPM02 20070906 ORIGINAL	23MP01 S23GWMPM-03 20071218 ORIGINAL	23MP01 FD-121807-01 20071218 DUPLICATE	23MP01 S23GWMPM-04 20080221 ORIGINAL
Inorganics, Filtered (continued) (µg/L)									
LEAD	13	NA	30	1.3 J	1.8 J	1.1 U	2.1 U	2.8 U	1.4 U
MAGNESIUM	NUT	NA	NA	7,200	7,480	6,980	7,250	7,300	8,020
MANGANESE	NE	NA	NA	645	664	708	764	770	815
NICKEL	880	NA	NA	1.1 U	0.88 U	0.78 J	1.0	0.64	0.66
POTASSIUM	NUT	NA	NA	5,090	5,390	5,320	5,360	5,390	5,390
SELENIUM	50	NA	NA	1.5 U	1.7 J	2.4 U	1.5 U	2.3 U	2.2 U
SODIUM	NUT	NA	NA	46,600	48,400	52,600	50,400	51,400	52,100
ZINC	123	NA	200	21.4 J	19.5 J	15	18.6	20.8	26
Petroleum Hydrocarbons (µg/L)									
ETPH (C09-C36)	NE	NE	2500[5]	55 J	79 U	140 J	160 U	1600 J	75 U
Petroleum Hydrocarbons, Filtered (µg/L)									
ETPH (C09-C36)	NE	NE	2500[5]	NA	NA	NA	NA	NA	75 U

1 Connecticut Remediation Standard Regulations (January 1996) and Comprehensive List of Approved Additional Polluting Substances Criteria and Alternative Criteria (October 2005).
2 Proposed Revisions to Connecticut's Remediation Standard Regulations, Volatilization Criteria (March 2003).
3 NSB-NLON General Permit for the Discharge of Stormwater Associated with Industrial Activity (DEP-PERD-GP-014, Issuance Date: October 1, 2002 and Modified Date: July 15, 2003).
4 Criteria is for hexavalent chromium
5 Criteria is for oil and grease.
BOLD Sample results that exceed a criterion are shown in bold font.
NA Not Applicable
NE Not Established
NUT Essential Nutrient

ATTACHMENT A.5

RISKS BASED ON QUARTERLY UNDERDRAIN METERING PIT SAMPING RESULTS

TABLE 2.1
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
SITE 23 - UNDERDRAIN METERING PIT SAMPLING
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe:
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	CAS Number	Chemical	Minimum Concentration(1)	Maximum Concentration(1)	Units	Sample of Maximum Concentration	Frequency of Detection	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Concentrations(4)	Screening Toxicity Value(5)	Potential ARAR/TBC	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Site 23	**Volatile Organic Compounds**														
	71-43-2	Benzene	0.2 J	0.2 J	ug/L	S23GWMPM04	1/4	0.5 - 0.5	0.2	NA	0.35 C	1 5 5	CTDEP RSR FED-MCL CTDEP-MCL	No	BSL
	75-27-4	Bromodichloromethane	0.3 J	0.3 J	ug/L	S23GWMPM01	1/4	0.5 - 0.5	0.3	NA	0.18 C	0.56 80 80	CTDEP RSR FED-MCL CTDEP-MCL	Yes	ASL
	67-66-3	Chloroform	2 J	3 J	ug/L	S23GWMPM01	1/4	0.5 - 0.5	3	NA	0.17 C	6 80 80	CTDEP RSR FED-MCL CTDEP-MCL	Yes	ASL
	156-59-2	cis-1,2-Dichloroethene	0.2 J	0.3 J	ug/L	S23GWMPM01 S23GWMPM02	4/4	0.5 - 0.5	0.3	NA	6.1 N	70 70 70	CTDEP RSR FED-MCL CTDEP-MCL	No	BSL
	110-82-7	Cyclohexane	0.1 J	0.1 J	ug/L	S23GWMPM02	1/4	0.5 - 0.5	0.1	NA	1000 N	NA NA NA	NA NA NA	No	NTX
	98-82-8	Isopropylbenzene	0.09 J	0.1 J	ug/L	S23GWMPM01 S23GWMPM02	2/4	0.5 - 0.5	0.1	NA	66 N	30 NA NA	CTDEP RSR NA NA	No	BSL
	1634-04-4	Methyl Tert-Butyl Ether	0.4 J	1	ug/L	S23GWMPM01	4/4	-	1	NA	11 C	70 NA NA	CTDEP RSR NA NA	No	BSL
	127-18-4	Tetrachloroethene	0.2 J	0.4 J	ug/L	S23GWMPM02	4/4	-	0.4	NA	0.1 C	5 5 5	CTDEP RSR FED-MCL CTDEP-MCL	Yes	ASL
	79-01-6	Trichloroethene	0.3 J	0.5 J	ug/L	S23GWMPM02	4/4	-	0.5	NA	0.028 C	5 5 5	CTDEP RSR FED-MCL CTDEP-MCL	Yes	ASL
	PAHs														
		1-Methylnaphthalene	0.048 J	0.96 J	ug/L	S23GWMPM-03	1/4	0.2 - 0.21	0.96	NA	0.62 N	49 NA NA	CTDEP RSR NA NA	Yes	ASL
	91-57-6	2-Methylnaphthalene	0.16 J	1.1 J	ug/L	S23GWMPM-03	2/4	0.2 - 0.21	1.1	NA	0.62 N	49 NA NA	CTDEP RSR NA NA	Yes	ASL
	100-01-6	4-Nitroaniline	0.75 J	0.75 J	ug/L	S23GWMPM-03	1/4	0.2 - 1	0.75	NA	3.2 C	21 NA NA	CTDEP RSR NA NA	No	BSL
	83-32-9	Acenaphthene	0.029 J	0.83 J	ug/L	S23GWMPM-03	1/4	0.2 - 0.21	0.83	NA	37 N	NA NA NA	NA NA NA	No	BSL
	208-96-8	Acenaphthylene	0.9 J	0.9 J	ug/L	S23GWMPM-03	1/4	0.2 - 0.21	0.9	NA	37 N(8)	420 NA NA	CTDEP RSR NA NA	No	BSL
	120-12-7	Anthracene	0.92 J	0.92 J	ug/L	S23GWMPM-03	1/4	0.2 - 0.21	0.92	NA	180 N	2000 NA NA	CTDEP RSR NA NA	No	BSL
	56-55-3	Benzo(a)anthracene	1 J	1 J	ug/L	S23GWMPM-03	1/4	0.041 - 0.07	1	NA	0.092 C	0.06 NA NA	CTDEP RSR NA NA	Yes	ASL
	50-32-8	Benzo(a)pyrene	0.35 J	0.35 J	ug/L	S23GWMPM-03	1/4	0.2 - 0.21	0.35	NA	0.0092 C	0.2 0.2 0.2	CTDEP RSR FED-MCL CTDEP-MCL	Yes	ASL
	205-99-2	Benzo(b)fluoranthene	0.64 J	0.64 J	ug/L	S23GWMPM-03	1/4	0.075 - 0.082	0.64	NA	0.092 C	0.08 NA NA	CTDEP RSR NA NA	Yes	ASL
	191-24-2	Benzo(g,h,i)perylene	0.31	0.31	ug/L	S23GWMPM-03	1/4	0.2 - 0.21	0.31	NA	18 N(9)	NA NA NA	NA NA NA	No	BSL
	207-08-9	Benzo(k)fluoranthene	0.53 J	0.53 J	ug/L	S23GWMPM-03	1/4	0.2 - 0.21	0.53	NA	0.92 C	0.5 NA NA	CTDEP RSR NA NA	Yes	ASL

TABLE 2.1
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
SITE 23 - UNDERDRAIN METERING PIT SAMPLING
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe:
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	CAS Number	Chemical	Minimum Concentration[1]	Maximum Concentration[1]	Units	Sample of Maximum Concentration	Frequency of Detection	Range of Nondetects[2]	Concentration Used for Screening[3]	Background Concentrations[4]	Screening Toxicity Value[5]	Potential ARAR/TBC	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection[6]
	218-01-9	Chrysene	0.76 J	0.76 J	ug/L	S23GWMPM-03	1/4	0.2 - 0.21	0.76	NA	9.2 C	4.8 NA NA	CTDEP RSR NA NA	No	BSL
	53-70-3	Dibenzo(a,h)anthracene	0.14 J	0.14 J	ug/L	S23GWMPM-03	1/4	0.2 - 0.21	0.14	NA	0.0029 C	0.2 NA NA	CTDEP RSR NA NA	Yes	ASL
	206-44-0	Fluoranthene	1.1 J	1.1 J	ug/L	S23GWMPM-03	1/4	0.2 - 0.21	1.1	NA	150 N	280 NA NA	CTDEP RSR NA NA	No	BSL
	86-73-7	Fluorene	0.97 J	0.97 J	ug/L	S23GWMPM-03	1/4	0.2 - 0.21	0.97	NA	24 N	280 NA NA	CTDEP RSR NA NA	No	BSL
	118-74-1	Hexachlorobenzene	1.2 J	1.2 J	ug/L	S23GWMPM-03	1/4	0.2 - 1	1.2	NA	0.042 C	1 1 1	CTDEP RSR FED-MCL CTDEP-MCL	Yes	ASL
	87-68-3	Hexachlorobutadiene	0.64 J	0.64 J	ug/L	S23GWMPM-03	1/4	0.099 - 0.48	0.64	NA	0.86 C	49 NA 50	CTDEP RSR NA CTDEP-MCL	No	BSL
	193-39-5	Indeno(1,2,3-cd)pyrene	0.22	0.22	ug/L	S23GWMPM-03	1/4	0.2 - 0.21	0.22	NA	0.092 C	0.5 NA NA	CTDEP RSR NA NA	Yes	ASL
	91-20-3	Naphthalene	0.088 J	1 J	ug/L	S23GWMPM-03	1/4	0.2 - 0.21	1	NA	0.62 N	280 NA NA	CTDEP RSR NA NA	Yes	ASL
	85-01-8	Phenanthrene	0.98 J	0.98 J	ug/L	S23GWMPM-03	1/4	0.2 - 0.21	0.98	NA	18 N[9]	200 NA NA	CTDEP RSR NA NA	No	BSL
	129-00-0	Pyrene	0.84 J	0.84 J	ug/L	S23GWMPM-03	1/4	0.2 - 0.21	0.84	NA	18 N	200 NA NA	CTDEP RSR NA NA	No	BSL
	PAHs, Filtered														
		1-Methylnaphthalene	0.093 J	0.093 J	ug/L	S23GWMPM04	1/1	-	0.093	NA	0.62 N[7]	49[10] NA NA	CTDEP RSR NA NA	No	BSL
	83-32-9	Acenaphthene	0.031 J	0.031 J	ug/L	S23GWMPM04	1/1	-	0.031	NA	37 N	NA NA NA	NA NA NA	No	BSL
	191-24-2	Benzo(g,h,i)perylene	0.13 J	0.13 J	ug/L	S23GWMPM04	1/1	-	0.13	NA	18 N[9]	NA NA NA	NA NA NA	No	BSL
	193-39-5	Indeno(1,2,3-cd)pyrene	0.22 J	0.22 J	ug/L	S23GWMPM04	1/1	-	0.22	NA	0.092 C	0.5 NA NA	CTDEP RSR NA NA	Yes	ASL
	91-20-3	Naphthalene	0.069 J	0.069 J	ug/L	S23GWMPM04	1/1	-	0.069	NA	0.62 N	280 NA NA	CTDEP RSR NA NA	No	BSL
	Inorganics														
	7429-90-5	Aluminum	21.8	473	ug/L	S23GWMPM01	4/4	-	473	3560	3600 N	NA 50 NA	NA FED-SMCL NA	Yes	ASL
	7440-38-2	Arsenic	3.1	13.9	ug/L	S23GWMPM02	2/4	2.2 - 4.7	13.9	1.92	0.045 C	50 10 10	CTDEP RSR FED-MCL CTDEP-MCL	Yes	ASL
	7440-39-3	Barium	48.2	87	ug/L	S23GWMPM02	4/4	-	87	227	260 N	1000 2000 2000	CTDEP RSR FED-MCL CTDEP-MCL	No	BSL
	7440-70-2	Calcium	32000	35800	ug/L	S23GWMPM01-D	4/4	-	35800	188000	NA	NA NA NA	NA NA NA	No	NUT
	15723-28-1	Chromium	0.41	2	ug/L	S23GWMPM02	2/4	0.28 - 0.94	2	49.9	11 N[11]	50 100 100	CTDEP RSR FED-MCL CTDEP-MCL	No	BSL

TABLE 2.1
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
SITE 23 - UNDERDRAIN METERING PIT SAMPLING
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe:
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	CAS Number	Chemical	Minimum Concentration[1]	Maximum Concentration[1]	Units	Sample of Maximum Concentration	Frequency of Detection	Range of Nondetects[2]	Concentration Used for Screening[3]	Background Concentrations[4]	Screening Toxicity Value[5]	Potential ARAR/TBC	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection[6]
	7440-48-4	Cobalt	0.53	0.66	ug/L	S23GWMPM-03	2/4	0.26 - 0.84	0.66	48.6	73 N	NA NA NA	NA NA NA	No	BSL
	7440-50-8	Copper	4.2	4.2	ug/L	S23GWMPM02	1/4	0.22 - 3	4.2	107	150 N	1300 1300 1300	CTDEP RSR FED-MCL CTDEP-MCL	No	BSL
	7439-89-6	Iron	4380	70800	ug/L	S23GWMPM02	4/4	-	70800	28200	1100 N	NA 300 NA	CTDEP RSR FED-SMCL CTDEP-MCL	Yes	ASL
	7439-92-1	Lead	2.2	9.3	ug/L	S23GWMPM01-D	2/4	1.4 - 2.5	9.3	6.63	NA	15 15 15	CTDEP RSR FED-MCL CTDEP-MCL	No	BSL
	7439-95-4	Magnesium	7020	7660	ug/L	S23GWMPM01-D S23GWMPM-03	4/4	-	7660	191000	NA	NA NA NA	NA NA NA	No	NUT
	7439-96-5	Manganese	661	858	ug/L	S23GWMPM-03	4/4	-	858	11700	88 N	NA 50 NA	NA FED-SMCL NA	Yes	ASL
	7440-02-0	Nickel	0.46	0.64	ug/L	S23GWMPM04	2/4	0.41 - 1	0.64	32.2	73 N	100 NA 100	CTDEP RSR NA CTDEP-MCL	No	BSL
	7440-09-7	Potassium	5150	5590	ug/L	S23GWMPM-03	4/4	-	5590	70800	NA	NA NA NA	NA NA NA	No	NUT
	7782-49-2	Selenium	2 J	2 J	ug/L	S23GWMPM01-D	1/4	1.5 - 2.2	2	3.19	18 N	50 50 50	CTDEP RSR FED-MCL CTDEP-MCL	No	BSL
	7440-22-4	Silver	1.5	1.5	ug/L	S23GWMPM02	1/4	0.46 - 0.54	1.5	NA	18 N	36 100 50	NA FED-SMCL NA	No	BSL
	7440-23-5	Sodium	46900	53400	ug/L	S23GWMPM-03	4/4	-	53400	1900000	NA	NA NA NA	NA NA NA	No	NUT
	7440-62-2	Vanadium	3.7	3.7	ug/L	S23GWMPM02	1/4	0.29 - 1.4	3.7	10.2	3.6 N	50 NA NA	CTDEP RSR NA NA	Yes	ASL
	7440-66-6	Zinc	20 J	47.1	ug/L	S23GWMPM02	4/4	-	47.1	131	1100 N	5000 NA NA	CTDEP RSR NA NA	No	BSL
	Inorganics, Filtered														
	7429-90-5	Aluminum	20.4 J	36.7 J	ug/L	S23GWMPM01-D	3/4	19 - 19	36.7	64.4	3600 N	NA 50 NA	NA FED-SMCL NA	No	BSL
	7440-38-2	Arsenic	1.2 J	2.8	ug/L	S23GWMPM04	2/4	1.1 - 3.5	2.8	2.55	0.045 C	50 10 10	CTDEP RSR FED-MCL CTDEP-MCL	Yes	ASL
	7440-39-3	Barium	44.6	56.8	ug/L	S23GWMPM04	4/4	-	56.8	124	260 N	1000 2000 2000	CTDEP RSR FED-MCL CTDEP-MCL	No	BSL
	7440-70-2	Calcium	31400	36000	ug/L	S23GWMPM04	4/4	-	36000	152000	NA	NA NA NA	NA NA NA	No	NUT
	15723-28-1	Chromium	0.29 J	0.48	ug/L	S23GWMPM-03-D	2/4	0.38 - 1.2	0.48	16	11 N[11]	50 100 100	CTDEP RSR FED-MCL CTDEP-MCL	No	BSL
	7440-48-4	Cobalt	0.47 J	0.64	ug/L	S23GWMPM04	3/4	0.67 - 0.86	0.64	43.3	73 N	NA NA NA	NA NA NA	No	BSL
	7439-89-6	Iron	3470	4190	ug/L	S23GWMPM-03	4/4	-	4190	25300	1100 N	NA 300 NA	NA FED-SMCL NA	Yes	ASL

TABLE 2.1
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
SITE 23 - UNDERDRAIN METERING PIT SAMPLING
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe:
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	CAS Number	Chemical	Minimum Concentration[1]	Maximum Concentration[1]	Units	Sample of Maximum Concentration	Frequency of Detection	Range of Nondetects[2]	Concentration Used for Screening[3]	Background Concentrations[4]	Screening Toxicity Value[5]	Potential ARAR/TBC	Potential ARAR/TBC Source	COPC Flag	Rationale for Contaminant Deletion or Selection[6]
	7439-92-1	Lead	1.3 J	1.8 J	ug/L	S23GWMPM01-D	1/4	1.1 - 2.8	1.8	2.52	NA	15 15 15	CTDEP RSR FED-MCL CTDEP-MCL	No	BSL
	7439-95-4	Magnesium	6980	8020	ug/L	S23GWMPM04	4/4	-	8020	150000	NA	NA NA NA	NA NA NA	No	NUT
	7439-96-5	Manganese	645	815	ug/L	S23GWMPM04	4/4	-	815	9400	88 N	NA 50 NA	NA FED-SMCL NA	Yes	ASL
	7440-02-0	Nickel	0.64 J	1	ug/L	S23GWMPM-03	3/4	0.88 - 1.1	1	15.3	73 N	100 NA 100	NA NA NA	No	BSL
	7440-09-7	Potassium	5090	5390	ug/L	S23GWMPM01-D S23GWMPM-03-D S23GWMPM04	4/4	-	5390	60000	NA	NA NA NA	NA NA NA	No	NUT
	7782-49-2	Selenium	1.7 J	1.7 J	ug/L	S23GWMPM01-D	1/4	1.5 - 2.4	1.7	NA	18 N	50 50 50	CTDEP RSR FED-MCL CTDEP-MCL	No	BSL
	7440-23-5	Sodium	46600	52600	ug/L	S23GWMPM02	4/4	-	52600	1580000	NA	NA NA NA	NA NA NA	No	NUT
	7440-66-6	Zinc	15 J	26	ug/L	S23GWMPM04	4/4	-	26	109	1100 N	5000 NA NA	CTDEP RSR NA NA	No	BSL
	Petroleum Hydrocarbons														
		Total Petroleum Hydrocarbons	55 J	1600 J	ug/L	S23GWMPM-03-D	3/4	75 - 160	1600	NA	NA	500 NA NA	CTDEP RSR NA NA	Yes	ASL

Footnotes:
1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - Values are from the Basewide Groundwater Operable Unit Remedial Investigation Report (Tetra Tech, January 2002).
5 - USEPA Region IX Preliminary Remediation Goal (PRG). The noncarcinogenic values (denoted with a "N" flag) are the PRG divided by 10 to correspond to a target hazard quotient of 0.1. Carcinogenic values represent an incremental cancer risk of 1.0E-06 (carcinogens denoted with a "C" flag) (USEPA Region IX, October 2004, Updated December 28, 2004).
6 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level.
7 - Naphthalene is used as a surrogate for 1- and 2-methylnaphthalene.
8- Acenaphthene is used as a surrogate for acenaphthylene.
9 - Pyrene is used as a surrogate for benzo(g,h,i)perylene and phenanthrene.
10 - 2-methylnaphthalene is used as a surrogate for 1-methylnaphthalene.
11 - Value is for hexavalent chromium.

Shaded criterion indicates that the maximum detected concentration exceeds one or more screening criteria. Shaded chemical name indicates that the chemical was retained as a COPC.

Associated Samples
S23GWMPM01
S23GWMPM01-D
S23GWMPM02
S23GWMPM-03
S23GWMPM-03-D
S23GWMPM04

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirements To Be Considered
C = Carcinogen
COPC = Chemical Of Potential Concern
J = Estimated value
N = Noncarcinogen
NA = Not Applicable/Not Available
FED-MCL = Federal Maximum Contaminant Level (USEPA, 2006)
FED-SMCL = Federal Maximum Contaminant Level (USEPA, 2006)
CTDEP-RSR = Connecticut DEP Remediation Standard Regulations, 1996.
CTDEP-MCL = Connecticut DEP Maximum Contaminant Level.

Rationale Codes:
For selection as a COPC:
ASL = Above Screening Level/ARAR/TBC

For elimination as a COPC:
BSL = Below COPC Screening Level
NUT = Essential nutrient
NTX = No toxicity criteria
EPA1 = USEPA Region 1 does not advocate evaluation of this chemical

TABLE 3.1.RME
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURES - UNDERDRAIN METERING PIT
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Site 23	Bromodichloromethane	ug/L	0.26	(1)	0.3 J	0.3	ug/L	Maximum Detected Concentration	(2)
	Chloroform	ug/L	0.81	(1)	3 J	2.5	ug/L	Maximum Detected Concentration	(2,3)
	Tetrachloroethene	ug/L	0.31	(1)	0.4 J	0.4	ug/L	Maximum Detected Concentration	(2)
	Trichloroethene	ug/L	0.40	(1)	0.5 J	0.5	ug/L	Maximum Detected Concentration	(2)
	1-Methylnaphthalene	ug/L	0.20	(1)	0.96 J	0.492	ug/L	Maximum Detected Concentration	(2,3)
	2-Methylnaphthalene	ug/L	0.24	(1)	1.1 J	0.6	ug/L	Maximum Detected Concentration	(2,3)
	Benzo(a)anthracene	ug/L	0.15	(1)	1 J	0.51	ug/L	Maximum Detected Concentration	(2,3)
	Benzo(a)pyrene	ug/L	0.13	(1)	0.35 J	0.225	ug/L	Maximum Detected Concentration	(2,3)
	Benzo(b)fluoranthene	ug/L	0.11	(1)	0.64 J	0.3395	ug/L	Maximum Detected Concentration	(2,3)
	Benzo(k)fluoranthene	ug/L	0.16	(1)	0.53 J	0.315	ug/L	Maximum Detected Concentration	(2,3)
	Dibenzo(a,h)anthracene	ug/L	0.11	(1)	0.14 J	0.12	ug/L	Maximum Detected Concentration	(2,3)
	Hexachlorobenzene	ug/L	0.34	(1)	1.2 J	0.65	ug/L	Maximum Detected Concentration	(2,3)
	Indeno(1,2,3-cd)pyrene	ug/L	0.12	(1)	0.22	0.16	ug/L	Maximum Detected Concentration	(2,3)
	Naphthalene	ug/L	0.21	(1)	1 J	0.552	ug/L	Maximum Detected Concentration	(2,3)
	Aluminum	ug/L	169	(1)	473	322	ug/L	Maximum Detected Concentration	(2,3)
	Arsenic	ug/L	5.1	(1)	13.9	13.9	ug/L	Maximum Detected Concentration	(2)
	Iron	ug/L	23939	(1)	70800	70800	ug/L	Maximum Detected Concentration	(2)
	Manganese	ug/L	788	(1)	858	845	ug/L	Maximum Detected Concentration	(2,3)
	Vanadium	ug/L	1.2	(1)	3.7	3.7	ug/L	Maximum Detected Concentration	(2)

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration.

J - Estimated value.

1 - There were an insuffcent number of samples to calculate distribution statistics.

2 - There were only four rounds of results which is insufficient to calculate a temporal average, therefore the maximum detected concentration is used as the exposure point concentration.

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURES - UNDERDRAIN METERING PIT
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Construction Workers	Adult	Site 23	Daevent	Dermally Absorbed Dose per Event	Calculated	mg/cm2-event	U.S. EPA, 2004	Dermally Absorbed Dose (mg/kg/day) =
				SA	Skin Surface Available for Contact	3300	cm2	U.S. EPA, 2004	
				EV	Event Frequency	1	events/day	(1)	DAevent x EV x EF x ED x SA
				ET	Exposure Time	4	hours/day	(1)	BW x AT
				EF	Exposure Frequency	30	days/year	(1)	
				ED	Exposure Duration	1	years	(1)	See text for calculation of DAevent.
				BW	Body Weight	70	kg	U.S. EPA, 1989	
				AT-C	Averaging Time (Cancer)	25550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	365	days	U.S. EPA, 1989	

Sources:

1 - Professional judgment.

U.S. EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

Unit Intake Calculations

Ingestion Intake = (IR-GW x EF x ED)/(BW x AT)

Dermal Intake = (SA x EV x EF x ED)/(BW x AT)

Cancer Ingestion Intake = NA

Noncancer Ingestion Intake = NA

Cancer Dermal Intake = 5.54E-02

Noncancer Dermal Intake = 3.87E+00

TABLE 4.2.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURES - UNDERDRAIN METERING PIT
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Construction Workers	Adult	Site 23	CA	Chemical concentration in air	Calculated	mg/m3	VDEQ, 2004	Intake (mg/kg/day) =
				CW	Chemical concentration in water.	Average	ug/L		
				CF	Conversion Factor	0.001	mg/ug	--	CA x IR x ET x EF x ED
				IR	Inhalation Rate	2.5	m3/hour	U.S. EPA, 1993	BW x AT
				ET	Exposure Time	4	hours/day	(1)	
				EF	Exposure Frequency	30	days/year	(1)	CA = CW x CF x VF
				ED	Exposure Duration	1	years	(1)	
				BW	Body Weight	70	kg	U.S. EPA, 1989	
				AT-C	Averaging Time (Cancer)	25550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	365	days	U.S. EPA, 1989	
				VF	Volatilization Factor	Calculated	(mg/m3)/(mg/L)	VDEQ, 2004	

Notes:

1 - Professional judgment.

U.S. EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

U.S. EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

VDEQ, 2004: Virginia Department of Environmental Quality (VDEQ, online- http://www.deq.state.va.us/vrprisk/homepage.html).

Unit Intake Calculations

Inhalation Intake = (IR x ET x EF x ED)/(BW x AT)

Cancer Inhalation Intake = 1.68E-04 Noncancer Inhalation Intake = 1.17E-02

TABLE 4.3.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURES - UNDERDRAIN METERING PIT

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Residents	Child	Site 23	CGW	Chemical Concentration in Groundwater	Max or 95% UCL	mg/kg	U.S. EPA, 2002a	Chronic Daily Intake (CDI) (mg/kg/day) =
				CF	Conversion Factor	0.001	mg/ug	--	
				IR-GW	Ingestion Rate of Groundwater	1.5	L/day	U.S. EPA, 1994	CW x CF x IR-GW x EF x ED
				EF	Exposure Frequency	350	days/year	U.S. EPA, 1994	BW x AT
				ED1	Exposure Duration (Age 0 - 2)	2	years	U.S. EPA, 1989	
				ED2	Exposure Duration (Age 2 - 6)	4	years	U.S. EPA, 1989	
				BW	Body Weight	15	kg	U.S. EPA, 1991	
				AT-C	Averaging Time (Cancer)	25550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2190	days	U.S. EPA, 1989	
Dermal	Residents	Child	Site 23	Daevent	Dermally Absorbed Dose per Event	Calculated	mg/cm2-event	U.S. EPA, 2004	Dermally Absorbed Dose (mg/kg/day) =
				SA	Skin Surface Available for Contact	6,600	cm2	U.S. EPA, 2004	
				EV	Event Frequency	1	events/day	U.S. EPA, 2004	DAevent x EV x EF x ED x SA
				ET	Exposure Time	0.25	hours/day	U.S. EPA, 1997	BW x AT
				EF	Exposure Frequency	350	days/year	U.S. EPA, 1994	
				ED1	Exposure Duration (Age 0 - 2)	2	years	U.S. EPA, 1989	See text for calculation of DAevent.
				ED2	Exposure Duration (Age 2 - 6)	4	years	U.S. EPA, 1989	
				BW	Body Weight	15	kg	U.S. EPA, 1991	
				AT-C	Averaging Time (Cancer)	25550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2190	days	U.S. EPA, 1989	

Sources:

U.S. EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

U.S. EPA, 1991: Risk Assessment Guidance for Superfund - Supplemental Guidance- Standard Default Exposure Factors Interim Final.

U.S. EPA, 1994: U.S. EPA Region I Risk Updates, August 1994.

U.S. EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa

U.S. EPA, 2002:Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. OSWER 9285.6-10, December.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

Unit Intake Calculations

Ingestion Intake = (IR-GW x EF x ED)/(BW x AT)

Dermal Intake = (SA x EV x EF x ED)/(BW x AT)

Cancer Ingestion Intake (Age 0 - 2) = 2.74E-06

Cancer Ingestion Intake (Age 2 - 6) = 5.48E-06

Cancer Dermal Intake (Age 0 - 2) = 1.21E+01

Cancer Dermal Intake (Age 2 - 6) = 2.41E+01

Noncancer Ingestion Intake = 9.59E-05

Noncancer Dermal Intake = 4.22E+02

TABLE 4.4.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURES - UNDERDRAIN METERING PIT

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Residents	Adult	Site 23	CGW	Chemical Concentration in Groundwater	95% UCL or Max	ug/L	U.S. EPA, 2002	Chronic Daily Intake (CDI) (mg/kg/day) =
				CF	Conversion Factor	0.001	mg/ug	--	
				IR-GW	Ingestion Rate of Groundwater	2	L/day	U.S. EPA, 1994	CW x CF x IR-GW x EF x ED
				EF	Exposure Frequency	350	days/year	U.S. EPA, 1994	BW x AT
				ED1	Exposure Duration (Age 10 - 16)	10	years	U.S. EPA, 1989	
				ED2	Exposure Duration (Age 16 - 30)	14	years	U.S. EPA, 1989	
				BW	Body Weight	70	kg	U.S. EPA, 1989	
				AT-C	Averaging Time (Cancer)	25,550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,650	days	U.S. EPA, 1989	
Dermal	Residents	Adult	Site 23	Daevent	Dermally Absorbed Dose per Event	Calculated	mg/cm2-event	U.S. EPA, 2004	Dermally Absorbed Dose (mg/kg/day) =
				SA	Skin Surface Available for Contact	18,000	cm2	U.S. EPA, 2004	
				EV	Event Frequency	1	events/day	U.S. EPA, 2004	DAevent x EV x EF x ED x SA
				ET	Exposure Time	0.25	hours/day	U.S. EPA, 2004	BW x AT
				EF	Exposure Frequency	350	days/year	U.S. EPA, 1994	
				ED1	Exposure Duration (Age 10 - 16)	10	years	U.S. EPA, 1989	See text for calculation of DAevent.
				ED2	Exposure Duration (Age 16 - 30)	14	years	U.S. EPA, 1989	
				BW	Body Weight	70	kg	U.S. EPA, 1989	
				AT-C	Averaging Time (Cancer)	25,550	days	U.S. EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,650	days	U.S. EPA, 1989	

Sources:

U.S. EPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

U.S. EPA, 1991: Risk Assessment Guidance for Superfund - Supplemental Guidance- Standard Default Exposure Factors Interim Final.

U.S. EPA, 1994: U.S. EPA Region I Risk Updates, August 1994.

U.S. EPA, 1997: Exposure Factors Handbook. U.S. EPA/600/8-95/002FA.

U.S. EPA, 2002: Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. OSWER 9285.6-10.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

Unit Intake Calculations

Ingestion Intake = (IR-GW x EF x ED)/(BW x AT)

Dermal Intake = (SA x EV x EF x ED)/(BW x AT)

Cancer Ingestion Intake Age 10 - 16) = 3.91E-06   Cancer Dermal Intake Age 10 - 16) = 3.52E+01

Cancer Ingestion Intake Age 16 - 30) = 5.48E-06   Cancer Dermal Intake (Age 16 - 30) = 4.93E+01

Noncancer Ingestion Intake = 6.58E-05   Noncancer Dermal Intake = 5.92E+02

TABLE 4.5
INTERMEDIATE VARIABLES FOR CALCULATING DA(EVENT)
SITE 23 - UNDERDRAIN METERING PIT
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Media	Dermal Absorption Fraction (soil)	FA	Kp		T(event)		Tau		T*		B
			Value	Value	Units	Value	Units	Value	Units	Value	Units	Value
Volatile Organic Compounds												
Bromodichloromethane	Groundwater	NA	1	4.6E-03	cm/hr	(1)	hr	8.8E-01	hr	2.1E+00	hr	2.3E-02
Chloroform	Groundwater	NA	1	6.8E-03	cm/hr	(1)	hr	5.0E-01	hr	1.2E+00	hr	2.9E-02
Tetrachloroethene	Groundwater	NA	1	3.3E-02	cm/hr	(1)	hr	9.1E-01	hr	2.2E+00	hr	1.7E-01
Trichloroethene	Groundwater	NA	1	1.2E-02	cm/hr	(1)	hr	5.8E-01	hr	1.4E+00	hr	5.1E-02
Semivolatile Organic Compounds												
1-Methylnaphthalene	Groundwater	NA	1	9.1E-02	cm/hr	(1)	hr	6.6E-01	hr	1.6E+00	hr	4.2E-01
2-Methylnaphthalene	Groundwater	NA	1	8.9E-02	cm/hr	(1)	hr	6.6E-01	hr	1.6E+00	hr	4.1E-01
Benzo(a)anthracene(2)	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene(2)	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene(2)	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene(2)	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene(2)	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	Groundwater	NA	0.9	1.3E-01	cm/hr	(1)	hr	4.2E+00	hr	1.6E+01	hr	8.7E-01
Indeno(1,2,3-cd)pyrene(2)	Groundwater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	Groundwater	NA	1	4.7E-02	cm/hr	(1)	hr	5.6E-01	hr	1.3E+00	hr	2.0E-01
Inorganics												
Aluminum	Groundwater	NA	1	1.0E-03	cm/hr	(1)	hr	NA	NA	NA	NA	NA
Arsenic	Groundwater	NA	1	1.0E-03	cm/hr	(1)	hr	NA	NA	NA	NA	NA
Iron	Groundwater	NA	1	1.0E-03	cm/hr	(1)	hr	NA	NA	NA	NA	NA
Manganese	Groundwater	NA	1	1.0E-03	cm/hr	(1)	hr	NA	NA	NA	NA	NA
Vanadium	Groundwater	NA	1	1.0E-03	cm/hr	(1)	hr	NA	NA	NA	NA	NA

Notes:
All values from EPA's Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final, July 2004.
1 - T_{event} is 4 hours for the construction worker and 0.25 hours for the child and adult resident.
2 - RAGS Part E recommends that dermal exposures to PAHs in water should not be quantitatively evaluated in the risk assessment.
FA = Fraction Absorbed Water
Kp = Dermal Permeability Coefficient of Compound in Water
T(event) = Event Duration
Tau = Lag Time
T* = Time to Reach Steady-State
B = Dimensionless Ratio of the Permeability Coefficient of a Compound Through the Stratum Corneum Relative to its Permeability Coefficient Across the Viable Epidermis
NA = Not applicable.

TABLE 5.1
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
SITE 23 - UNDERDRAIN METERING PIT SAMPLING
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal[1]	Absorbed RfD for Dermal[2]		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD:Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Volatile Organic Compounds										
Bromodichloromethane	Chronic	2.0E-01	mg/kg/day	1	2.0E-01	mg/kg/day	Kidney	1000/1	IRS	4/24/2008
Chloroform	Chronic	1.0E-02	mg/kg/day	1	1.0E-02	mg/kg/day	Liver	100/1	IRS	4/24/2008
Tetrachloroethene	Chronic	1.0E-02	mg/kg/day	1	1.0E-02	mg/kg/day	Liver	1000/1	IRS	4/24/2008
Trichloroethene	Chronic	3.0E-04	mg/kg/day	1	3.0E-04	mg/kg/day	Liver, Kidney	NA	USEPA(1)	8/2001
Semivolatile Organic Compounds										
1-Methylnaphthalene[3]	Chronic	4.0E-03	mg/kg/day	1	4.0E-03	mg/kg/day	Lungs	1000/1	IRS	4/24/2008
2-Methylnaphthalene	Chronic	4.0E-03	mg/kg/day	1	4.0E-03	mg/kg/day	Lungs	1000/1	IRS	4/24/2008
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	Chronic	8.0E-04	mg/kg/day	1	8.0E-04	mg/kg/day	Liver	100/1		
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	Chronic	2.0E-02	mg/kg/day	1	2.0E-02	mg/kg/day	Body Weight	3000/1	IRS	4/24/2008
Inorganics										
Aluminum	Chronic	1.0E+00	mg/kg/day	1	1.0E+00	mg/kg/day	CNS	100	PPRTV	10/23/2006
Arsenic	Chronic	3.0E-04	mg/kg/day	1	3.0E-04	mg/kg/day	Skin, CVS	3/1	IRS	4/24/2008
Iron	Chronic	7.0E-01	mg/kg/day	1	7.0E-01	mg/kg/day	GS	1.5	PPRTV	9/11/2006
Manganese	Chronic	2.4E-02	mg/kg/day	0.04	9.6E-04	mg/kg/day	CNS	1/3	IRS	4/24/2008
Vanadium	Chronic	1.0E-03	mg/kg/day	0.026	2.6E-05	mg/kg/day	Kidney	300	USEPA III	10/11/2007

Notes:
1 - U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.
2 - Adjusted dermal RfD = Oral RfD x Oral Absorption Efficiency for Dermal.
3 -Value is for 2-methylnaphthalene.

Definitions:
CNS = Central Nervous System
CVS = Cardiovascular system
USEPA(1) = Draft Trichloroethylene Health Risk Assessment: Synthesis and Characterization, August 2001.
USEPA III = U.S. EPA Region 3 RBC Table, October 11, 2007.
GS = Gastrointestinal system
IRIS = Integrated Risk Information System
NA = Not Applicable

TABLE 5.2
NON-CANCER TOXICITY DATA -- INHALATION
SITE 23 - UNDERDRAIN METERING PIT SAMPLING
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Extrapolated RfD[1]		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfC : Target Organ(s)	
		Value	Units	Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Volatile Organic Compounds									
Bromodichloromethane	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	Chronic	2.8E-01	mg/m^3	8.0E-02	(mg/kg/day)	Liver	NA	USEPA III	10/11/2007
Trichloroethene	Chronic	3.5E-02	mg/m3	1.0E-02	(mg/kg/day)	Liver, CNS	NA	USEPA(1)	8/2001
Semivolatile Organic Compounds									
1-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	Chronic	3.0E-03	mg/m^3	8.6E-04	(mg/kg/day)	Nasal	3000/1	IRIS	4/24/2008
Inorganics									
Aluminum	Chronic	0.005	mg/m3	1.4E-03	(mg/kg/day)	CNS	300	PPRTV	10/23/2006
Arsenic	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	Chronic	5.0E-05	mg/m^3	1.4E-05	(mg/kg/day)	CNS	1000/1	IRIS	4/24/2008
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
1 - Extrapolated RfD = RfC *20m^3/day / 70 kg

Definitions:
CNS = Central Nervous System
EPA III = U.S. EPA Region 3 RBC Table, October 11, 2007.
HEAST= Health Effects Assessment Summary Tables
IRIS = Integrated Risk Information System
NA = Not Applicable
USEPA(1) = Draft Trichloroethylene Health Risk Assessment: Synthesis and Characterization, August 2001.

TABLE 6.1
CANCER TOXICITY DATA -- ORAL/DERMAL
SITE 23 - UNDERDRAIN METERING PIT SAMPLING
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal(1)	Absorbed Cancer Slope Factor for Dermal(2)		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units		Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Volatile Organic Compounds								
Bromodichloromethane	6.2E-02	(mg/kg/day)-1	1	6.2E-02	(mg/kg/day)-1	B2	IRIS	4/24/2008
Chloroform	NA	NA	NA	NA	NA	B2	IRIS	4/24/2008
Tetrachloroethene	5.4E-01	(mg/kg/day)-1	1	5.4E-01	(mg/kg/day)-1	NA	IRIS	4/24/2008
Trichloroethene	4.0E-01	(mg/kg/day)-1	1	4.0E-01	(mg/kg/day)-1	C	USEPA(1)	8/2001
Semivolatile Organic Compounds								
1-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	7.3E-01	(mg/kg/day)-1	1	7.3E-01	(mg/kg/day)-1	B2	USEPA(2)	7/1993
Benzo(a)pyrene	7.3E+00	(mg/kg/day)-1	1	7.3E+00	(mg/kg/day)-1	B2	IRIS	7/20/2007
Benzo(b)fluoranthene	7.3E-01	(mg/kg/day)-1	1	7.3E-01	(mg/kg/day)-1	B2	USEPA(2)	7/1993
Benzo(k)fluoranthene	7.3E-02	(mg/kg/day)-1	1	7.3E-02	(mg/kg/day)-1	B2	USEPA(2)	7/1993
Dibenzo(a,h)anthracene	7.3E+00	(mg/kg/day)-1	1	7.3E+00	(mg/kg/day)-1	B2	USEPA(2)	7/1993
Hexachlorobenzene	1.6E+00	(mg/kg/day)-1	1	1.6E+00	(mg/kg/day)-1	B2	IRIS	4/24/2008
Indeno(1,2,3-cd)pyrene	7.3E-01	(mg/kg/day)-1	1	7.3E-01	(mg/kg/day)-1	B2	USEPA(2)	7/1993
Naphthalene	NA	NA	NA	NA	NA	C	IRIS	4/24/2008
Inorganics								
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	1.5E+00	$(mg/kg/day)^{-1}$	1	1.5E+00	$(mg/kg/day)^{-1}$	A	IRIS	4/24/2008
Iron	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	D	IRIS	4/24/2008
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
1 - U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.
2 - Adjusted cancer slope factor for dermal = Oral cancer slope factor / Oral Absorption Efficiency for Dermal.
USEPA III = U.S. EPA Region 3 RBC Table, October 11, 2007.
IRIS = Integrated Risk Information System.
NA = Not Available.

EPA Group:
A - Human carcinogen.
B1 - Probable human carcinogen - indicates that limited human data are available.
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans .
C - Possible human carcinogen.
D - Not classifiable as a human carcinogen.
E - Evidence of noncarcinogenicity.

USEPA(1) = Draft Trichloroethylene Health Risk Assessment: Synthesis and Characterization, August 2001.

USEPA(2) = U.S. EPA, Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons, July 1993, EPA/600/R-93/089.

TABLE 6.2
CANCER TOXICITY DATA -- INHALATION
SITE 23 - UNDERDRAIN METERING PIT SAMPLING
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Unit Risk		Inhalation Cancer Slope Factor[1]		Weight of Evidence/ Cancer Guideline Description	Unit Risk : Inhalation CSF	
	Value	Units	Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Volatile Organic Compounds							
Bromodichloromethane	NA	NA	NA	NA	B2	IRIS	4/24/2008
Chloroform	2.3E-05	$(ug/m^3)^{-1}$	8.1E-02	$(mg/kg/day)^{-1}$	B2	IRIS	4/24/2008
Tetrachloroethene	5.7E-06	$(ug/m^3)^{-1}$	2.0E-02	$(mg/kg/day)^{-1}$	NA	USEPA III	10/11/2007
Trichloroethene	1.1E-04	(ug/m3)-1	4.0E-01	(mg/kg/day)-1	C	USEPA(1)	8/2001
Semivolatile Organic Compounds							
1-Methylnaphthalene	NA	NA	NA	NA	NA	NA	4/24/2008
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	4/24/2008
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	8.9E-04	$(ug/m^3)^{-1}$	3.1E+00	$(mg/kg/day)^{-1}$	NA	USEPA III	10/11/2007
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	4.6E-04	$(ug/m^3)^{-1}$	1.6E+00	$(mg/kg/day)^{-1}$	B2	IRIS	4/24/2008
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA	C	IRIS	4/24/2008
Inorganics							
Aluminum	NA	NA	NA	NA	NA	NA	NA
Arsenic	4.3E-03	$(ug/m^3)^{-1}$	1.5E+01	$(mg/kg/day)^{-1}$	A	IRIS	4/24/2008
Iron	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	D	IRIS	4/24/2008
Vanadium	NA	NA	NA	NA	NA	NA	NA

Notes:
1 - Inhalation CSF = Unit Risk * 70 kg / $20m^3$/day.

Definitions:
IRIS = Integrated Risk Information System.
NA = Not Available.
USEPA III = U.S. EPA Region 3 RBC Table, October 11, 2007.
USEPA(1) = Draft Trichloroethylene Health Risk Assessment: Synthesis and Characterization, August 2001.

EPA Group:
A - Human carcinogen.
B1 - Probable human carcinogen - indicates that limited human data are available.
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans .
C - Possible human carcinogen.
D - Not classifiable as a human carcinogen.
E - Evidence of noncarcinogenicity.

TABLE 7.1.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURES - UNDERDRAIN METERING PIT
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Construction Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Site 23	Dermal	Bromodichloromethane	0.300	ug/L	4.4E-10	(mg/kg/day)	6.2E-02	(mg/kg/day)$^{-1}$	2.7E-11	3.1E-08	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.000002
				Chloroform	2.500	ug/L	4.6E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.2E-07	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.00003
				Tetrachloroethene	0.400	ug/L	4.1E-09	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	2.2E-09	2.9E-07	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.00003
				Trichloroethene	0.500	ug/L	1.6E-09	(mg/kg/day)	4.0E-01	(mg/kg/day)$^{-1}$	6.5E-10	1.1E-07	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.0004
				1-Methylnaphthalene	0.492	ug/L	1.1E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	8.0E-07	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.0002
				2-Methylnaphthalene	0.600	ug/L	1.4E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	9.7E-07	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.0002
				Benzo(a)anthracene	1	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)pyrene	0.2	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.3	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	0.32	ug/L	0.0E+00	(mg/kg/day)	7.3E-02	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Dibenzo(a,h)anthracene	0.12	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Hexachlorobenzene	0.65	ug/L	4.9E-08	(mg/kg/day)	1.6E+00	(mg/kg/day)$^{-1}$	7.9E-08	3.4E-06	(mg/kg/day)	8.0E-04	(mg/kg/day)	0.004
				Indeno(1,2,3-cd)pyrene	0	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Naphthalene	1	ug/L	6.6E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	4.6E-07	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.00002
				Aluminum	322.00	ug/L	7.1E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	5.0E-06	(mg/kg/day)	1.0E+00	(mg/kg/day)	0.000005
				Arsenic	13.90	ug/L	3.1E-09	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	4.6E-09	2.2E-07	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.0007
				Iron	70800.00	ug/L	1.6E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.1E-03	(mg/kg/day)	7.0E-01	(mg/kg/day)	0.002
				Manganese	845.0	ug/L	1.9E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.3E-05	(mg/kg/day)	9.6E-04	(mg/kg/day)	0.01
				Vanadium	3.7	ug/L	8.2E-10	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	5.7E-08	(mg/kg/day)	2.6E-05	(mg/kg/day)	0.002
			Exp. Route Total								8.6E-08					0.02
		Exposure Point Total									8.6E-08					0.02
	Exposure Medium Total										8.6E-08					0.02
	Air	Site 23	Inhalation	Bromodichloromethane	8.4E-6	mg/m3	1.4E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	9.9E-08	(mg/kg/day)	NA	(mg/kg/day)	--
				Chloroform	8.4E-5	mg/m3	1.4E-08	(mg/kg/day)	8.1E-02	(mg/kg/day)$^{-1}$	1.1E-09	9.8E-07	(mg/kg/day)	1.4E-02	(mg/kg/day)	0.00007
				Tetrachloroethene	1.1E-5	mg/m3	1.9E-09	(mg/kg/day)	2.0E-02	(mg/kg/day)$^{-1}$	3.9E-11	1.3E-07	(mg/kg/day)	8.0E-02	(mg/kg/day)	0.000002
				Trichloroethene	1.6E-5	mg/m3	2.7E-09	(mg/kg/day)	4.0E-01	(mg/kg/day)$^{-1}$	1.1E-09	1.9E-07	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.00002
				1-Methylnaphthalene	1.4E-5	mg/m3	2.4E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.7E-07	(mg/kg/day)	NA	(mg/kg/day)	--
				2-Methylnaphthalene	9.5E-6	mg/m3	1.6E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.1E-07	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)anthracene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)pyrene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	3.1E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Dibenzo(a,h)anthracene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Hexachlorobenzene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	1.6E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Indeno(1,2,3-cd)pyrene	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Naphthalene	1.6E-5	mg/m3	2.7E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.9E-07	(mg/kg/day)	9.0E-04	(mg/kg/day)	0.0002
				Aluminum	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	1.4E-03	(mg/kg/day)	--
				Arsenic	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	1.5E+01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Iron	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Manganese	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	1.4E-05	(mg/kg/day)	--
				Vanadium	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
			Exp. Route Total								2.3E-09					0.0003
		Exposure Point Total									2.3E-09					0.0003
	Exposure Medium Total										2.3E-09					0.0003
Medium Total											8.8E-08					0.02
										Total of Receptor Risks Across All Media	8.8E-08				Total of Receptor Hazards Across All Media	0.02

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURES - UNDERDRAIN METERING PIT

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Site 23	Ingestion	Bromodichloromethane	0.300	ug/L	2.5E-06	(mg/kg/day)	6.2E-02	(mg/kg/day)$^{-1}$	1.5E-07	2.9E-05	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.001
				Chloroform	2.500	ug/L	2.1E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	2.4E-04	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.02
				Tetrachloroethene	0.400	ug/L	3.3E-06	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	1.8E-06	3.8E-05	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.004
				Trichloroethene	0.500	ug/L	4.1E-06	(mg/kg/day)	4.0E-01	(mg/kg/day)$^{-1}$	1.6E-06	4.8E-05	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.2
				1-Methylnaphthalene	0.492	ug/L	4.0E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	4.7E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.01
				2-Methylnaphthalene	0.600	ug/L	4.9E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	5.8E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.01
				Benzo(a)anthracene	0.510	ug/L	2.2E-05	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	1.6E-05	4.9E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)pyrene	0.225	ug/L	9.9E-06	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	7.2E-05	2.2E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.340	ug/L	1.5E-05	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	1.1E-05	3.3E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	0.315	ug/L	1.4E-05	(mg/kg/day)	7.3E-02	(mg/kg/day)$^{-1}$	1.0E-06	3.0E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Dibenzo(a,h)anthracene	0.120	ug/L	5.3E-06	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	3.8E-05	1.2E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Hexachlorobenzene	0.650	ug/L	5.3E-06	(mg/kg/day)	1.6E+00	(mg/kg/day)$^{-1}$	8.5E-06	6.2E-05	(mg/kg/day)	8.0E-04	(mg/kg/day)	0.08
				Indeno(1,2,3-cd)pyrene	0.160	ug/L	7.0E-06	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	5.1E-06	1.5E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Naphthalene	0.552	ug/L	4.5E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	5.3E-05	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.003
				Aluminum	322	ug/L	2.6E-03	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.1E-02	(mg/kg/day)	1.0E+00	(mg/kg/day)	0.03
				Arsenic	13.90	ug/L	1.1E-04	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	1.7E-04	1.3E-03	(mg/kg/day)	3.0E-04	(mg/kg/day)	4.4
				Iron	70800	ug/L	5.8E-01	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	6.8E+00	(mg/kg/day)	7.0E-01	(mg/kg/day)	9.7
				Manganese	845	ug/L	6.9E-03	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	8.1E-02	(mg/kg/day)	2.4E-02	(mg/kg/day)	3.4
				Vanadium	3.70	ug/L	3.0E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.5E-04	(mg/kg/day)	1.0E-03	(mg/kg/day)	0.4
			Exp. Route Total								3.3E-04					18
			Dermal	Bromodichloromethane	0.300	ug/L	2.2E-08	(mg/kg/day)	6.2E-02	(mg/kg/day)$^{-1}$	1.3E-09	7.6E-07	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.00004
				Chloroform	2.500	ug/L	2.0E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	7.0E-06	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.0007
				Tetrachloroethene	0.400	ug/L	2.1E-07	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	1.1E-07	7.4E-06	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.0007
				Trichloroethene	0.500	ug/L	7.4E-08	(mg/kg/day)	4.0E-01	(mg/kg/day)$^{-1}$	3.0E-08	2.6E-06	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.009
				1-Methylnaphthalene	0.492	ug/L	6.0E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	2.1E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.005
				2-Methylnaphthalene	0.600	ug/L	7.2E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	2.5E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.006
				Benzo(a)anthracene	0.510	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)pyrene	0.225	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.340	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	0.315	ug/L	0.0E+00	(mg/kg/day)	7.3E-02	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Dibenzo(a,h)anthracene	0.120	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Hexachlorobenzene	0.650	ug/L	2.7E-06	(mg/kg/day)	1.6E+00	(mg/kg/day)$^{-1}$	4.3E-06	9.4E-05	(mg/kg/day)	8.0E-04	(mg/kg/day)	0.1
				Indeno(1,2,3-cd)pyrene	0.160	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Naphthalene	0.552	ug/L	3.2E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.1E-06	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.0006
				Aluminum	322	ug/L	9.7E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.4E-05	(mg/kg/day)	1.0E+00	(mg/kg/day)	0.00003
				Arsenic	13.90	ug/L	4.2E-08	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	6.3E-08	1.5E-06	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.005
				Iron	70800	ug/L	2.1E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	7.5E-03	(mg/kg/day)	7.0E-01	(mg/kg/day)	0.01
				Manganese	845	ug/L	2.5E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	8.9E-05	(mg/kg/day)	9.6E-04	(mg/kg/day)	0.09
				Vanadium	3.70	ug/L	1.1E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.9E-07	(mg/kg/day)	2.6E-05	(mg/kg/day)	0.02
			Exp. Route Total								4.5E-06					0.3
		Exposure Point Total									3.3E-04					18
	Exposure Medium Total										3.3E-04					18

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURES - UNDERDRAIN METERING PIT

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Air	Site 23	Inhalation	Bromodichloromethane	0.300	ug/L	2.5E-06	(mg/kg/day)	6.2E-02	$(mg/kg/day)^{-1}$	1.5E-07	2.9E-05	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.001
				Chloroform	2.500	ug/L	2.1E-05	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	--	2.4E-04	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.02
				Tetrachloroethene	0.400	ug/L	3.3E-06	(mg/kg/day)	5.4E-01	$(mg/kg/day)^{-1}$	1.8E-06	3.8E-05	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.004
				Trichloroethene	0.500	ug/L	4.1E-06	(mg/kg/day)	4.0E-01	$(mg/kg/day)^{-1}$	1.6E-06	4.8E-05	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.2
				1-Methylnaphthalene	0.492	ug/L	4.0E-06	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	--	4.7E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.01
				2-Methylnaphthalene	0.600	ug/L	4.9E-06	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	--	5.8E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.01
				Benzo(a)anthracene	0.510	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	$(mg/kg/day)^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)pyrene	0.225	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	$(mg/kg/day)^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.340	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	$(mg/kg/day)^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	0.315	ug/L	0.0E+00	(mg/kg/day)	7.3E-02	$(mg/kg/day)^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Dibenzo(a,h)anthracene	0.120	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	$(mg/kg/day)^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Hexachlorobenzene	0.650	ug/L	0.0E+00	(mg/kg/day)	1.6E+00	$(mg/kg/day)^{-1}$	--	0.0E+00	(mg/kg/day)	8.0E-04	(mg/kg/day)	--
				Indeno(1,2,3-cd)pyrene	0.160	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	$(mg/kg/day)^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Naphthalene	0.552	ug/L	4.5E-06	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	--	5.3E-05	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.003
				Aluminum	322	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	--	0.0E+00	(mg/kg/day)	1.0E+00	(mg/kg/day)	--
				Arsenic	13.90	ug/L	0.0E+00	(mg/kg/day)	1.5E+00	$(mg/kg/day)^{-1}$	--	0.0E+00	(mg/kg/day)	3.0E-04	(mg/kg/day)	--
				Iron	70800	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	--	0.0E+00	(mg/kg/day)	7.0E-01	(mg/kg/day)	--
				Manganese	845	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	--	0.0E+00	(mg/kg/day)	2.4E-02	(mg/kg/day)	--
				Vanadium	3.70	ug/L	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	--	0.0E+00	(mg/kg/day)	1.0E-03	(mg/kg/day)	--
			Exp. Route Total								3.6E-06					0.2
		Exposure Point Total									3.6E-06					0.2
	Exposure Medium Total										3.6E-06					0.2
Medium Total											3.4E-04					19
										Total of Receptor Risks Across All Media	3.4E-04				Total of Receptor Hazards Across All Media	19

Note:
Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.

TABLE 7.3.RME
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURES - UNDERDRAIN METERING PIT
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Site 23	Ingestion	Bromodichloromethane	0.300	ug/L	2.3E-06	(mg/kg/day)	6.2E-02	(mg/kg/day)$^{-1}$	1.5E-07	2.0E-05	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.0010
				Chloroform	2.500	ug/L	2.0E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.6E-04	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.02
				Tetrachloroethene	0.400	ug/L	3.1E-06	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	1.7E-06	2.6E-05	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.003
				Trichloroethene	0.500	ug/L	3.9E-06	(mg/kg/day)	4.0E-01	(mg/kg/day)$^{-1}$	1.6E-06	3.3E-05	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.1
				1-Methylnaphthalene	0.492	ug/L	3.9E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.2E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.008
				2-Methylnaphthalene	0.600	ug/L	4.7E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.9E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.010
				Benzo(a)anthracene	0.510	ug/L	8.0E-06	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	5.8E-06	3.4E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)pyrene	0.225	ug/L	3.5E-06	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	2.6E-05	1.5E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.340	ug/L	5.3E-06	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	3.9E-06	2.2E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	0.315	ug/L	4.9E-06	(mg/kg/day)	7.3E-02	(mg/kg/day)$^{-1}$	3.6E-07	2.1E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Dibenzo(a,h)anthracene	0.120	ug/L	1.9E-06	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	1.4E-05	7.9E-06	(mg/kg/day)	NA	(mg/kg/day)	--
				Hexachlorobenzene	0.650	ug/L	5.1E-06	(mg/kg/day)	1.6E+00	(mg/kg/day)$^{-1}$	8.1E-06	4.3E-05	(mg/kg/day)	8.0E-04	(mg/kg/day)	0.05
				Indeno(1,2,3-cd)pyrene	0.160	ug/L	2.5E-06	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	1.8E-06	1.1E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Naphthalene	0.552	ug/L	4.3E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.6E-05	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.002
				Aluminum	322	ug/L	2.5E-03	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.1E-02	(mg/kg/day)	1.0E+00	(mg/kg/day)	0.02
				Arsenic	13.90	ug/L	1.1E-04	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	1.6E-04	9.1E-04	(mg/kg/day)	3.0E-04	(mg/kg/day)	3.0
				Iron	70800	ug/L	5.5E-01	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	4.7E+00	(mg/kg/day)	7.0E-01	(mg/kg/day)	6.7
				Manganese	845	ug/L	6.6E-03	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	5.6E-02	(mg/kg/day)	2.4E-02	(mg/kg/day)	2.3
				Vanadium	3.70	ug/L	2.9E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.4E-04	(mg/kg/day)	1.0E-03	(mg/kg/day)	0.2
			Exp. Route Total								2.3E-04					12
			Dermal	Bromodichloromethane	0.300	ug/L	1.5E-07	(mg/kg/day)	6.2E-02	(mg/kg/day)$^{-1}$	9.4E-09	1.1E-06	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.00005
				Chloroform	2.500	ug/L	1.4E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	9.8E-06	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.0010
				Tetrachloroethene	0.400	ug/L	1.5E-06	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	8.0E-07	1.0E-05	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.001
				Trichloroethene	0.500	ug/L	5.2E-07	(mg/kg/day)	4.0E-01	(mg/kg/day)$^{-1}$	2.1E-07	3.6E-06	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.01
				1-Methylnaphthalene	0.492	ug/L	4.2E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.0E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.007
				2-Methylnaphthalene	0.600	ug/L	5.1E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.6E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.009
				Benzo(a)anthracene	0.510	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)pyrene	0.225	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.340	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	0.315	ug/L	0.0E+00	(mg/kg/day)	7.3E-02	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Dibenzo(a,h)anthracene	0.120	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Hexachlorobenzene	0.650	ug/L	1.9E-05	(mg/kg/day)	1.6E+00	(mg/kg/day)$^{-1}$	3.0E-05	1.3E-04	(mg/kg/day)	8.0E-04	(mg/kg/day)	0.2
				Indeno(1,2,3-cd)pyrene	0.160	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Naphthalene	0.552	ug/L	2.2E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.6E-05	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.0008
				Aluminum	322	ug/L	6.8E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	4.8E-05	(mg/kg/day)	1.0E+00	(mg/kg/day)	0.00005
				Arsenic	13.90	ug/L	2.9E-07	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	4.4E-07	2.1E-06	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.007
				Iron	70800	ug/L	1.5E-03	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.0E-02	(mg/kg/day)	7.0E-01	(mg/kg/day)	0.01
				Manganese	845	ug/L	1.8E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.3E-04	(mg/kg/day)	9.6E-04	(mg/kg/day)	0.1
				Vanadium	3.70	ug/L	7.6E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	5.5E-07	(mg/kg/day)	2.6E-05	(mg/kg/day)	0.02
			Exp. Route Total								3.1E-05					0.4
		Exposure Point Total									2.6E-04					13
	Exposure Medium Total										2.6E-04					13

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURES - UNDERDRAIN METERING PIT

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Air	Site 23	Inhalation	Bromodichloromethane	0.300	ug/L	2.3E-06	(mg/kg/day)	6.2E-02	(mg/kg/day)$^{-1}$	1.5E-07	2.0E-05	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.0010
				Chloroform	2.500	ug/L	2.0E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	1.6E-04	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.02
				Tetrachloroethene	0.400	ug/L	3.1E-06	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	1.7E-06	2.6E-05	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.003
				Trichloroethene	0.500	ug/L	3.9E-06	(mg/kg/day)	4.0E-01	(mg/kg/day)$^{-1}$	1.6E-06	3.3E-05	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.1
				1-Methylnaphthalene	0.492	ug/L	3.9E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.2E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.008
				2-Methylnaphthalene	0.600	ug/L	4.7E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.9E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.010
				Benzo(a)anthracene	0.510	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(a)pyrene	0.225	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(b)fluoranthene	0.340	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Benzo(k)fluoranthene	0.315	ug/L	0.0E+00	(mg/kg/day)	7.3E-02	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Dibenzo(a,h)anthracene	0.120	ug/L	0.0E+00	(mg/kg/day)	7.3E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Hexachlorobenzene	0.650	ug/L	0.0E+00	(mg/kg/day)	1.6E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	8.0E-04	(mg/kg/day)	--
				Indeno(1,2,3-cd)pyrene	0.160	ug/L	0.0E+00	(mg/kg/day)	7.3E-01	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Naphthalene	0.552	ug/L	4.3E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	3.6E-05	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.002
				Aluminum	322	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	1.0E+00	(mg/kg/day)	--
				Arsenic	13.90	ug/L	0.0E+00	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	3.0E-04	(mg/kg/day)	--
				Iron	70800	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	7.0E-01	(mg/kg/day)	--
				Manganese	845	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	2.4E-02	(mg/kg/day)	--
				Vanadium	3.70	ug/L	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	--	0.0E+00	(mg/kg/day)	1.0E-03	(mg/kg/day)	--
			Exp. Route Total								3.4E-06					0.1
		Exposure Point Total									3.4E-06					0.1
	Exposure Medium Total										3.4E-06					0.1
Medium Total											2.6E-04					13
										Total of Receptor Risks Across All Media	2.6E-04				Total of Receptor Hazards Across All Media	13

Note:
Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES - UNDERDRAIN METERING PIT
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Construction Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 23	Bromodichloromethane	--	–	3E-11	–	3E-11	Kidney	–	--	0.000002	0.000002
			Chloroform	--	–	--	–	--	Liver	–	--	0.00003	0.00003
			Tetrachloroethene	--	–	2E-09	–	2E-09	Liver	–	--	0.00003	0.00003
			Trichloroethene	--	–	6E-10	–	6E-10	Liver, Kidney	–	--	0.0004	0.0004
			1-Methylnaphthalene	--	–	--	–	--	Lungs	–	--	0.0002	0.0002
			2-Methylnaphthalene	--	–	--	–	--	Lungs	–	--	0.0002	0.0002
			Benzo(a)anthracene	--	–	--	–	--	NA	–	--	–	–
			Benzo(a)pyrene	--	–	--	–	--	NA	–	--	–	–
			Benzo(b)fluoranthene	--	–	--	–	--	NA	–	--	–	–
			Benzo(k)fluoranthene	--	–	--	–	--	NA	–	--	–	–
			Dibenzo(a,h)anthracene	--	–	--	–	--	NA	–	--	–	–
			Hexachlorobenzene	--	–	8E-08	–	8E-08	Liver	–	--	0.004	0.004
			Indeno(1,2,3-cd)pyrene	--	–	--	–	--	NA	–	--	–	–
			Naphthalene	--	–	--	–	--	Body Weight	–	--	0.00002	0.00002
			Aluminum	--	–	--	–	--	CNS	–	--	0.000005	0.000005
			Arsenic	--	–	5E-09	–	5E-09	Skin, CVS	–	--	0.0007	0.0007
			Iron	--	–	--	–	--	GS	–	--	0.002	0.002
			Manganese	--	–	--	–	--	CNS	–	--	0.01	0.01
			Vanadium	--	–	--	–	--	Kidney	–	--	0.002	0.002
			Chemical Total	--	–	9E-08	–	9E-08		–	--	0.02	0.02
		Exposure Point Total						9E-08					0.02
	Exposure Medium Total							9E-08					0.02
	Groundwater	Site 23	Bromodichloromethane	–	--	–	–	--	NA	--	–	--	–
			Chloroform	–	1E-09	–	–	1E-09	Liver	--	0.00007	--	0.00007
			Tetrachloroethene	–	4E-11	–	–	4E-11	Liver	--	0.000002	--	0.000002
			Trichloroethene	–	1E-09	–	–	1E-09	Liver, CNS	--	0.00002	--	0.00002
			1-Methylnaphthalene	–	--	–	–	--	NA	--	–	--	–
			2-Methylnaphthalene	–	--	–	–	--	NA	--	–	--	–
			Benzo(a)anthracene	–	--	–	–	--	NA	--	–	--	–
			Benzo(a)pyrene	–	--	–	–	--	NA	--	–	--	–
			Benzo(b)fluoranthene	–	--	–	–	--	NA	--	–	--	–
			Benzo(k)fluoranthene	–	--	–	–	--	NA	--	–	--	–
			Dibenzo(a,h)anthracene	–	--	–	–	--	NA	--	–	--	–
			Hexachlorobenzene	–	--	–	–	--	NA	--	–	--	–
			Indeno(1,2,3-cd)pyrene	–	--	–	–	--	NA	--	–	--	–

TABLE 9.1.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURES - UNDERDRAIN METERING PIT

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Construction Workers
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 23	Naphthalene	--	--	--	--	--	NA	--	0.0002	--	0.0002
			Aluminum	--	--	--	--	--	CNS	--	--	--	--
			Arsenic	--	--	--	--	--	NA	--	--	--	--
			Iron	--	--	--	--	--	NA	--	--	--	--
			Manganese	--	--	--	--	--	CNS	--	--	--	--
			Vanadium	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	2E-09	--	--	2E-09		--	0.0003	--	0.0003
		Exposure Point Total						2E-09					0.0003
	Exposure Medium Total							2E-09					0.0003
Medium Total								9E-08					0.02
Receptor Total							Receptor Risk Total	9E-08				Receptor HI Total	0.02

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES - UNDERDRAIN METERING PIT
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 23	Bromodichloromethane	2E-07	–	1E-09	–	2E-07	Kidney	0.001	--	0.00004	0.001
			Chloroform	--	–	--	–	--	Liver	0.02	--	0.0007	0.02
			Tetrachloroethene	2E-06	–	1E-07	–	2E-06	Liver	0.004	--	0.0007	0.005
			Trichloroethene	2E-06	–	3E-08	–	2E-06	Liver, Kidney	0.2	--	0.009	0.2
			1-Methylnaphthalene	--	–	--	–	--	Lungs	0.01	--	0.005	0.02
			2-Methylnaphthalene	--	–	--	–	--	Lungs	0.01	--	0.006	0.02
			Benzo(a)anthracene	2E-05	–	--	–	2E-05	NA	–	--	–	–
			Benzo(a)pyrene	7E-05	–	--	–	7E-05	NA	–	--	–	–
			Benzo(b)fluoranthene	1E-05	–	--	–	1E-05	NA	–	--	–	–
			Benzo(k)fluoranthene	1E-06	–	--	–	1E-06	NA	–	--	–	–
			Dibenzo(a,h)anthracene	4E-05	–	--	–	4E-05	NA	–	--	–	–
			Hexachlorobenzene	9E-06	–	4E-06	–	1E-05	Liver	0.08	--	0.1	0.2
			Indeno(1,2,3-cd)pyrene	5E-06	–	--	–	5E-06	NA	–	--	–	–
			Naphthalene	--	–	--	–	--	Body Weight	0.003	--	0.0006	0.003
			Aluminum	--	–	--	–	--	CNS	0.03	--	0.00003	0.03
			Arsenic	2E-04	–	6E-08	–	2E-04	Skin, CVS	4	--	0.005	4
			Iron	--	–	--	–	--	GS	10	--	0.01	10
			Manganese	--	–	--	–	--	CNS	3	--	0.09	3
			Vanadium	--	–	--	–	--	Kidney	0.4	--	0.02	0.4
			Chemical Total	3E-04	–	4E-06	–	3E-04		18	--	0.3	18
		Exposure Point Total						3E-04					18
	Exposure Medium Total							3E-04					18
	Groundwater	Site 23	Bromodichloromethane	–	2E-07	–	–	2E-07	NA	--	0.001	--	0.001
			Chloroform	–	--	–	–	--	Liver	--	0.02	--	0.02
			Tetrachloroethene	–	2E-06	–	–	2E-06	Liver	--	0.004	--	0.004
			Trichloroethene	–	2E-06	–	–	2E-06	Liver, CNS	--	0.2	--	0.2
			1-Methylnaphthalene	–	--	–	–	--	NA	--	0.01	--	0.01
			2-Methylnaphthalene	–	--	–	–	--	NA	--	0.01	--	0.01
			Benzo(a)anthracene	–	--	–	–	--	NA	--	–	--	–
			Benzo(a)pyrene	–	--	–	–	--	NA	--	–	--	–
			Benzo(b)fluoranthene	–	--	–	–	--	NA	--	–	--	–
			Benzo(k)fluoranthene	–	--	–	–	--	NA	--	–	--	–
			Dibenzo(a,h)anthracene	–	--	–	–	--	NA	--	–	--	–
			Hexachlorobenzene	–	--	–	–	--	NA	--	–	--	–
			Indeno(1,2,3-cd)pyrene	–	--	–	–	--	NA	--	–	--	–

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES - UNDERDRAIN METERING PIT
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 23	Naphthalene	--	--	--	--	--	NA	--	0.003	--	0.003
			Aluminum	--	--	--	--	--	CNS	--	--	--	--
			Arsenic	--	--	--	--	--	NA	--	--	--	--
			Iron	--	--	--	--	--	NA	--	--	--	--
			Manganese	--	--	--	--	--	CNS	--	--	--	--
			Vanadium	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	4E-06	--	--	4E-06		--	0.2	--	0.2
		Exposure Point Total						4E-06					0.2
	Exposure Medium Total							4E-06					0.2
Medium Total								3E-04					19
Receptor Total							Receptor Risk Total	3E-04				Receptor HI Total	19

Note:
Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.

Total Body Weight HI	0.003
Total CNS HI	4
Total CVS HI	4
Total GS HI	10
Total Kidney HI	0.5
Total Liver HI	0.6
Total Skin HI	4

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES - UNDERDRAIN METERING PIT
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 23	Bromodichloromethane	1E-07	–	9E-09	–	2E-07	Kidney	0.0010	--	0.00005	0.001
			Chloroform	--	–	--	–	--	Liver	0.02	--	0.0010	0.02
			Tetrachloroethene	2E-06	–	8E-07	–	2E-06	Liver	0.003	--	0.001	0.004
			Trichloroethene	2E-06	–	2E-07	–	2E-06	Liver, Kidney	0.1	--	0.01	0.1
			1-Methylnaphthalene	--	–	--	–	--	Lungs	0.008	--	0.007	0.02
			2-Methylnaphthalene	--	–	--	–	--	Lungs	0.010	--	0.009	0.02
			Benzo(a)anthracene	6E-06	–	--	–	6E-06	NA	–	--	–	–
			Benzo(a)pyrene	3E-05	–	--	–	3E-05	NA	–	--	–	–
			Benzo(b)fluoranthene	4E-06	–	--	–	4E-06	NA	–	--	–	–
			Benzo(k)fluoranthene	4E-07	–	--	–	4E-07	NA	–	--	–	–
			Dibenzo(a,h)anthracene	1E-05	–	--	–	1E-05	NA	–	--	–	–
			Hexachlorobenzene	8E-06	–	3E-05	–	4E-05	Liver	0.05	--	0.2	0.2
			Indeno(1,2,3-cd)pyrene	2E-06	–	--	–	2E-06	NA	–	--	–	–
			Naphthalene	--	–	--	–	--	Body Weight	0.002	--	0.0008	0.003
			Aluminum	--	–	--	–	--	CNS	0.02	--	0.00005	0.02
			Arsenic	2E-04	–	4E-07	–	2E-04	Skin, CVS	3	--	0.007	3
			Iron	--	–	--	–	--	GS	7	--	0.01	7
			Manganese	--	–	--	–	--	CNS	2	--	0.1	2
			Vanadium	--	–	--	–	--	Kidney	0.2	--	0.02	0.3
			Chemical Total	2E-04	–	3E-05	–	3E-04		12	--	0.4	13
		Exposure Point Total						3E-04					13
	Exposure Medium Total							3E-04					13
	Groundwater	Site 23	Bromodichloromethane	–	1E-07	–	–	1E-07	NA	--	0.0010	--	0.0010
			Chloroform	–	--	–	–	--	Liver	--	0.02	--	0.02
			Tetrachloroethene	–	2E-06	–	–	2E-06	Liver	--	0.003	--	0.003
			Trichloroethene	–	2E-06	–	–	2E-06	Liver, CNS	--	0.1	--	0.1
			1-Methylnaphthalene	–	--	–	–	--	NA	--	0.008	--	0.008
			2-Methylnaphthalene	–	--	–	–	--	NA	--	0.010	--	0.010
			Benzo(a)anthracene	–	--	–	–	--	NA	--	–	--	–
			Benzo(a)pyrene	–	--	–	–	--	NA	--	–	--	–
			Benzo(b)fluoranthene	–	--	–	–	--	NA	--	–	--	–
			Benzo(k)fluoranthene	–	--	–	–	--	NA	--	–	--	–
			Dibenzo(a,h)anthracene	–	--	–	–	--	NA	--	–	--	–
			Hexachlorobenzene	–	--	–	–	--	NA	--	–	--	–
			Indeno(1,2,3-cd)pyrene	–	--	–	–	--	NA	--	–	--	–

TABLE 9.3.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURES - UNDERDRAIN METERING PIT

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 23	Naphthalene	–	--	–	–	--	NA	--	0.002	--	0.002
			Aluminum	–	--	–	–	--	CNS	--	–	--	–
			Arsenic	–	--	–	–	--	NA	--	–	--	–
			Iron	–	--	–	–	--	NA	--	–	--	–
			Manganese	–	--	–	–	--	CNS	--	–	--	–
			Vanadium	–	--	–	–	--	NA	--	–	--	–
			Chemical Total	–	3E-06	–	–	3E-06		--	0.1	--	0.1
		Exposure Point Total						3E-06					0.1
	Exposure Medium Total							3E-06					0.1
Medium Total								3E-04					13
Receptor Total							Receptor Risk Total	3E-04				Receptor HI Total	13

Note:

Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.

Total Body Weight HI	0.003
Total CNS HI	3
Total CVS HI	3
Total GS HI	7
Total Kidney HI	0.4
Total Liver HI	0.5
Total Skin HI	3

TABLE 9.4.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES - UNDERDRAIN METERING PIT
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Lifelong (Child and Adult)

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 23	Bromodichloromethane	3E-07	–	1E-08	–	3E-07					
			Chloroform	--	–	--	–	--					
			Tetrachloroethene	3E-06	–	9E-07	–	4E-06					
			Trichloroethene	3E-06	–	2E-07	–	3E-06					
			1-Methylnaphthalene	--	–	--	–	--					
			2-Methylnaphthalene	--	–	--	–	--					
			Benzo(a)anthracene	2E-05	–	--	–	2E-05					
			Benzo(a)pyrene	1E-04	–	--	–	1E-04					
			Benzo(b)fluoranthene	1E-05	–	--	–	1E-05					
			Benzo(k)fluoranthene	1E-06	–	--	–	1E-06					
			Dibenzo(a,h)anthracene	5E-05	–	--	–	5E-05					
			Hexachlorobenzene	2E-05	–	3E-05	–	5E-05					
			Indeno(1,2,3-cd)pyrene	7E-06	–	--	–	7E-06					
			Naphthalene	--	–	--	–	--					
			Aluminum	--	–	--	–	--					
			Arsenic	3E-04	–	5E-07	–	3E-04					
			Iron	--	–	--	–	--					
			Manganese	--	–	--	–	--					
			Vanadium	--	–	--	–	--					
			Chemical Total	6E-04	–	4E-05	–	6E-04					
		Exposure Point Total						6E-04					
	Exposure Medium Total							6E-04					
	Groundwater	Site 23	Bromodichloromethane	–	3E-07	–	–	3E-07					
			Chloroform	–	--	–	–	--					
			Tetrachloroethene	–	3E-06	–	–	3E-06					
			Trichloroethene	–	3E-06	–	–	3E-06					
			1-Methylnaphthalene	–	--	–	–	--					
			2-Methylnaphthalene	–	--	–	–	--					
			Benzo(a)anthracene	–	--	–	–	--					
			Benzo(a)pyrene	–	--	–	–	--					
			Benzo(b)fluoranthene	–	--	–	–	--					
			Benzo(k)fluoranthene	–	--	–	–	--					
			Dibenzo(a,h)anthracene	–	--	–	–	--					
			Hexachlorobenzene	–	--	–	–	--					
			Indeno(1,2,3-cd)pyrene	–	--	–	–	--					

TABLE 9.4.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES - UNDERDRAIN METERING PIT
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Residents
Receptor Age: Lifelong (Child and Adult)

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 23	Naphthalene	--	--	--	--	--					
			Aluminum	--	--	--	--	--					
			Arsenic	--	--	--	--	--					
			Iron	--	--	--	--	--					
			Manganese	--	--	--	--	--					
			Vanadium	--	--	--	--	--					
			Chemical Total	--	7E-06	--	--	7E-06					
		Exposure Point Total						7E-06					
	Exposure Medium Total							7E-06					
Medium Total								6E-04					
Receptor Total							Receptor Risk Total	6E-04					

Note:
Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.

E.3 VAPOR INTRUSION EVALUATION FOR OU9

From: Bob Jupin, Tetra Tech Risk Assessment Specialist
To: Corey Rich, Tetra Tech Project Manager
Date: May 30, 2008

Regarding: Vapor Intrusion Evaluation for Groundwater at Operable Unit (OU) 9

Groundwater data from Sites 2, 3, 7, 14, 15, 18, 20, and 23 which are within OU 9 were evaluated to determine if there were unacceptable risks associated with vapor intrusion into buildings. The most recent groundwater data that was available for each site was used in the evaluation. Concentrations of volatile organic compounds (VOCs) in groundwater were compared to screening criteria for vapor intrusion. Screening criteria were obtained from USEPA's *OSWER Draft Guidance for Evaluating the Vapor Intrusion into Indoor Air from Groundwater and Soils (Subsurface Vapor Intrusion Guidance), November 2002,* CTDEP's *Proposed Revisions - Connecticut's Remediation Standard Regulations Volatilization Criteria, March 2003,* and USEPA Region I (April 24, 2008). The screening criteria are for residential exposures and are based on an incremental lifetime cancer risk (ILCR) of 1×10^{-6} or a hazard index (HI) of 1. If the risk-based screening criterion is less than the maximum contaminant level (MCL) the 2002 USEPA guidance recommends using the MCL as the screening level. However, USEPA Region I guidance does not allow for MCLs to be used as screening criteria. USEPA Region I provided risk-based screening levels for those cases where the USEPA draft guidance recommended MCLs as screening levels. If chemicals were detected at concentrations exceeding either screening criteria, then the chemicals were further evaluated using USEPA's Johnson and Ettinger Vapor Intrusion Model (USEPA, February 2004). The results of the screening and modeling evaluations are presented below.

COMPARISON TO SCREENING CRITERIA FOR VAPOR INTRUSION

Site 2

Groundwater data presented in the Year 3 Annual Groundwater Monitoring Report for Area A Landfill (Tetra Tech, 2003) was used to evaluate the potential for vapor intrusion at Site 2. This was the last year that VOCs were analyzed for in groundwater samples collected at Site 2. VOCs were eliminated as a concern at Site 2 after eleven rounds of groundwater monitoring. A comparison of the detected concentrations of VOCs in groundwater samples from upgradient wells, downgradient wells in Area A Downstream, and downgradient wells in the Area A Wetland to the screening criteria are presented in Tables 1 through 3, respectively. Concentrations of all chemicals were below the CTDEP RSRs for vapor intrusion. Concentrations of chloroform exceeded the USEPA screening criterion in samples from upgradient well 4MW01S. Concentrations of trichloroethene exceeded the USEPA screening criterion in samples from upgradient monitoring well 4MW01S; downstream monitoring well 3MW37S, and wetlands monitoring well 2WMW46DS. Concentrations of tetrachloroethene exceeded the USEPA screening criterion in samples from wetlands monitoring well 2WMW39DS. Therefore, these chemicals were further evaluated using the Johnson and Ettinger Vapor Intrusion Model.

Site 3

Groundwater data presented in the Year 1 Annual Groundwater Monitoring Report for Sites 3 and 7 (Tetra Tech, 2007) was used to evaluate the potential for vapor intrusion at Site 3. A comparison of the detected concentrations of VOCs in groundwater samples to the screening criteria is presented in Table 4. Concentrations of chloroform exceeded the USEPA screening criterion in samples from monitoring wells 3MW15S, 3MW15D, 2MW16S, and 3MW16D. Concentrations of trichloroethene exceeded USEPA screening criterion in all four samples collected from monitoring well 2DMW16D. Concentrations of vinyl chloride in monitoring well 2DMW29S exceeded the USEPA screening criterion and CTDEP RSRs in groundwater samples collected during the 1st, 2nd, and 4th quarters. Therefore, chloroform, trichloroethene, and vinyl chloride were further evaluated using the Johnson and Ettinger Vapor Intrusion Model.

Site 7

Groundwater data presented in the Year 1 Annual Groundwater Monitoring Report for Sites 3 and 7 (Tetra Tech, 2007) was used to evaluate the potential for vapor intrusion at Site 7. A comparison of the detected concentrations of VOCs in groundwater samples to the screening criterion is presented in Table 5. Concentrations of trichloroethene exceeded the USEPA screening criterion in all four samples collected from monitoring wells 7MW05D and 7MW12I. Therefore, trichloroethene was further evaluated using the Johnson and Ettinger Vapor Intrusion Model.

Site 14

No VOCs were detected in groundwater samples collected at Site 14 during the Basewide Groundwater Operable Unit Remedial Investigation (BGOURI) (Tetra Tech, 2002) indicating that vapor intrusion is not a concern at Site 14.

Site 15

Groundwater data presented in the Basewide Groundwater Operable Unit Remedial Investigation Update/Feasibility Study Report (Tetra Tech, 2004) was used to evaluate the potential for vapor intrusion at Site 15. A comparison of the detected concentrations of VOCs in groundwater samples to the screening criteria is presented in Table 6. Chloroform was the only VOC detected in groundwater samples collected at Site 15. Chloroform is a common laboratory contaminant and is frequently detected in potable water samples. Chloroform was only detected in one sample at one temporary monitoring well (15TW03) and the detected concentration exceeded the USEPA screening criterion. Therefore, chloroform was further evaluated using the Johnson and Ettinger Vapor Intrusion Model.

Site 18

No VOCs were detected in groundwater samples collected at Site 18 during the BGOURI (Tetra Tech, 2002) indicating that vapor intrusion is not a concern at Site 18.

Site 20

Groundwater data presented in the BGOURI (Tetra Tech, 2002) was used to evaluate the potential for vapor intrusion at Site 20. A comparison of the detected concentrations of VOCs in groundwater samples to the screening criteria is presented in Table 7. 4-Methyl-2-pentanone and trichloroethene were the only VOCs detected in groundwater samples collected at Site 20. Trichloroethene was detected in the groundwater sample from monitoring well 2WCMW2S at a concentration exceeding the USEPA screening criterion. Therefore, trichloroethene was further evaluated using the Johnson and Ettinger Vapor Intrusion Model.

Site 23

Groundwater data presented in Year 1 Annual Monitoring Report for Site 23 Underdrain Metering Pit (Tetra Tech, 2008) was used to evaluate the potential for vapor intrusion at Site 23. A comparison of the detected concentrations of VOCs in groundwater samples to the screening criteria are presented in Table 8. Concentrations of chloroform detected in one sample and trichloroethene detected in four samples exceeded the USEPA screening criterion. Therefore, chloroform and trichloroethene were further evaluated using the Johnson and Ettinger Vapor Intrusion Model.

VAPOR INTRUSION MODELING

The following chemicals were detected at concentrations exceeding the screening criteria for vapor intrusion:

- Site 2 Upgradient – chloroform and trichloroethene
- Site 2 Area A Downstream – trichloroethene
- Site 2 Area A Wetlands – tetrachloroethene and trichloroethene
- Site 3 – chloroform, trichloroethene, and vinyl chloride
- Site 7 – trichloroethene
- Site 15 – chloroform
- Site 20 – trichloroethene
- Site 23 – chloroform and trichloroethene

These chemicals were further evaluated using USEPA's Johnson and Ettinger Vapor Intrusion Model. There are currently no buildings at any of the sites that are used for residential purposes, although there are some buildings that are used for industrial purposes. Therefore, the evaluation considered a hypothetical scenario where a residential building was constructed at the sites.

In accordance with USEPA Region I guidance (1999), there was not sufficient data available to calculate temporal averages at the monitoring wells; therefore, the maximum detected concentrations were used as the exposure point concentrations for the chemicals identified as exceeding the screening levels at each site. The boring logs for the monitoring wells where there were exceedances of the screening criteria were used to determine the Soil Conservation Services (SCS) soil type. Test results from the BGOURI were used to determine the bulk density and total porosity. The values used in the evaluation are presented in Table 9. Supporting information for Table 9 is included in Attachment A. Slab-on-grade construction was assumed for future residential construction due to the shallow groundwater depth at Site 3. At the Site 2 Wetlands the depth to groundwater was assumed to be 2 feet which represents the average depth to groundwater at monitoring wells 2WMW39DS and 2WMW46DS. At the other sites the shallowest depth to groundwater was used in the evaluation. Default parameters were used for the remaining model input parameters for the evaluation of residential exposures.

The USEPA vapor intrusion guidance does not provide any default parameters for evaluating industrial exposures. The USEPA default values of 250 days a year and 25 years were used for the exposure frequency and exposure duration, respectively (USEPA, December 2002) for industrial exposures. The CTDEP (March 2003) and ASTM (2004) default value of 0.83 hr^{-1} was used as the air exchange rate and 300 cm was used as the building height. The same input parameters that were used to evaluate residential exposures were used for the remaining input parameters.

Toxicity criteria for trichloroethene are not currently published on the USEPA's IRIS database or in USEPA's Health Effects Assessment Summary Tables (HEAST). USEPA has published draft toxicity criteria for trichloroethene in the *External Review Draft for Trichloroethylene Health Risk Assessment: Synthesis and Characterization* (2001). The draft toxicity criteria are currently undergoing peer review. Alternatively, the California EPA (CA EPA) has developed toxicity criteria for trichloroethene (2002). Both sets of toxicity criteria were used to estimate risks for exposures to trichloroethene. The draft USEPA guidance recommends values of 1.1×10^{-4} $(ug/m^3)^{-1}$ for the unit risk factor and 0.04 mg/m^3 for the reference concentration. CA EPA recommends values of 2.0×10^{-6} $(ug/m^3)^{-1}$ for the unit risk factor and 0.6 mg/m^3 for the reference concentration. As recommended by USEPA Region I, the unit risk factor for adult exposures of 4.4×10^{-6} $(ug/m^3)^{-1}$ was used for vinyl chloride. The toxicity criteria used in the evaluation are presented in Tables 10 and 11.

The results of the vapor intrusion modeling are summarized in Table 12. Outputs for the Johnson and Ettinger Vapor Intrusion Model are presented in Attachment B.

HIs for residential and industrial exposures to all chemicals at all sites were less than unity (1), indicating that adverse non-carcinogenic effects are not anticipated for these receptors under the defined exposure conditions.

Overall the ILCRs for residential and industrial exposures at all sites were less than or within the USEPA target risk range of 10^{-4} to 10^{-6}. ILCRs for residential and industrial exposures were less than or equal to 1×10^{-6} at Site 2 indicating that there is no significant risk from vapor intrusion at this site.

At Site 3 the ILCR for trichloroethene of 3×10^{-5} for residential exposures and 5×10^{-6} for industrial exposures based on the draft USEPA toxicity criteria exceeds the CTDEP acceptable level for cumulative exposures and the ILCRs of 7×10^{-6} for chloroform and 8×10^{-6} for vinyl chloride exceed the CTDEP acceptable level of 1×10^{-6} for individual chemicals. The ILCR for trichloroethene for residential exposures based on the Cal EPA toxicity and ILCRs for industrial exposures for trichloroethene, chloroform, and vinyl chloride are all less than or equal to 1×10^{-6}. Vinyl chloride was only detected at monitoring well 2DMW29S and trichloroethene and chloroform were not detected in groundwater samples from this monitoring well. Chloroform was detected in groundwater samples from monitoring wells 3MW15I, 3MW15S, 3MW16D, and 3MW16S. The maximum detected concentration of chloroform occurred at monitoring well 3MW16S. Trichloroethene and vinyl chloride were not detected at this monitoring well. Trichloroethene was detected in groundwater samples from monitoring wells 3MW16D and 2MW16D. At monitoring well 3MW16D, the only monitoring well where trichloroethene and chloroform were both detected, the cumulative ILCR for residential exposures is 2×10^{-5} based on the draft USEPA toxicity criteria, and 2×10^{-6} based on the Cal EPA toxicity criteria.

At Site 7 the ILCR for trichloroethene of 2×10^{-6} for residential exposures based on the draft USEPA toxicity criteria is less than the CTDEP acceptable level for cumulative exposures but exceeds the CTDEP acceptable level of 1×10^{-6} for individual chemicals. The ILCR for trichloroethene of 3×10^{-7} for industrial exposures based on draft USEPA toxicity criteria and ILCRs for of 2×10^{-7} and 3×10^{-8} for residential and industrial exposures, respectively, based on the Cal EPA toxicity criteria for trichloroethene are less than the CTDEP acceptable level for individual chemicals. Also the maximum detected concentration of trichloroethene in groundwater samples at Site 7 of 1 µg/L is less than the residential CTDEP RSR of 27 µg/L for vapor intrusion.

At Site 15 the ILCR of 4×10^{-6} for residential exposures is less than the CTDEP acceptable level for cumulative exposures but exceeds the CTDEP acceptable level of 1×10^{-6} for individual chemicals. The ILCR of 5×10^{-7} for industrial exposures is less than the CTDEP acceptable level for individual chemicals.

Also the maximum detected concentration of chloroform in groundwater samples at Site 15 of 3 µg/L is less than the residential CTDEP RSR of 26 µg/L for vapor intrusion.

At Site 20 the ILCR for trichloroethene of 4 x 10^{-6} for residential exposures based on the draft USEPA toxicity criteria is less than the CTDEP acceptable level for cumulative exposures but exceeds the CTDEP acceptable level of 1 x 10^{-6} for individual chemicals. The ILCR for trichloroethene of 6 x 10^{-7} for industrial exposures based on the draft USEPA toxicity criteria is less than the CTDEP acceptable level of 1 x 10^{-6} for individual chemicals. ILCRs for of 7 x 10^{-8} and 1 x 10^{-8} for residential and industrial exposures, respectively, based on the Cal EPA toxicity criteria for trichloroethene are less than the CTDEP acceptable level for individual chemicals. Also the maximum detected concentration of trichloroethene in groundwater samples at Site 20 of 5.02 µg/L is less than the residential CTDEP RSR of 27 µg/L for vapor intrusion.

At Site 23 for residential exposures the ILCR for chloroform of 2 x 10^{-6} and trichloroethene of 4 x 10^{-6} based on the draft USEPA toxicity criteria are less than the CTDEP acceptable level for cumulative exposures but exceeds the CTDEP acceptable level of 1 x 10^{-6} for individual chemicals. The ILCR for trichloroethene for residential exposures based on the Cal EPA toxicity and ILCRs for industrial exposures for trichloroethene and vinyl chloride are all less than 1 x 10^{-6}. Also the maximum detected concentration of chloroform in groundwater samples at Site 15 of 3 µg/L is less than the residential CTDEP RSR of 26 µg/L for vapor intrusion.

Preliminary Remediation Goals

The vapor intrusion model was also used to calculate site-specific, risk-based preliminary remediation goals (PRGs) for vapor intrusion at all the sites. The PRGs are presented in Table 13 and are based on a 1 x 10^{-6} risk level or a hazard index of 1. The model outputs for the PRGs are included in Attachment B. As recommended by USEPA Region I (April 2008), the PRGs for trichloroethene are based on the Cal EPA toxicity criteria. Also included in Table 13 are USEPA maximum contaminant levels (MCLs) and CTDEP RSRs. These criteria would be considered applicable or relevant and appropriate requirements (ARARs).

The CTDEP RSRs for vapor intrusion were also derived using the Johnson and Ettinger model, although CTDEP uses different input parameters than those recommended by USEPA. The most notable difference is that the CTDEP RSRs for trichloroethene are not risk-based but based on a background air concentration of 1 ug/m^3.

Uncertainty Analysis

The results of the vapor intrusion modeling are subject to the following sources of uncertainty:

- The model assumes an infinite source. The sources of VOCs at the sites have been removed and VOCs are no longer being released to groundwater. In addition, concentrations of VOCs in groundwater are decreasing with time.

- The model assumes that the areal extent of contamination is greater than that of the building floor in contact with the soil and that the contamination is homogeneously distributed within the zone of contamination. The groundwater concentrations from a single well were used as the exposure point concentrations for the model. It is not known if the extent of the groundwater plume is larger or smaller than the assumed building foot print.

- The model assumes that the contaminant exposure point concentration is present in groundwater at the soil/groundwater interface. The model does not consider the case when contaminated groundwater is present at depth and a relatively clean layer of groundwater is present at the aquifer surface. In this case, the clean layer of surficial groundwater may slow or restrict the migration of VOC vapors to the unsaturated zone. Modeling was done for several contaminants that were only detected in deep monitoring wells. It was conservatively assumed that these contaminants were present at the same concentrations at the soil/groundwater interface.

- The model does not take into account transformation processes.

- The default building area of 10 meters (32.8 feet) by 10 meters for residential exposures is based on a Michigan study and corresponds to the 10^{th} percentile floor space area for residential single family dwellings. The slab on grade scenario assumes a single floor dwelling 2.44 meters (8 feet) high for residential exposures and 3.0 meters (10 feet) for industrial exposures. The modeling results may be different for a building with different dimensions.

- As discussed above, at present there are no USEPA-approved toxicity criteria for trichloroethene. Risks were calculated in this evaluation using draft toxicity criteria published by USEPA (2001) and toxicity criteria developed by Cal EPA (2002). At the Association of State and Territorial Solid Waste Management Officials (ASTSWMO) meeting in San Diego, California on March 13, 2008, Mary T. Cooke of the USEPA's Federal Facilities Restoration and Reuse Office (FFRRO) announced USEPA provisional guidance for trichloroethene. The provisional guidance is based on the Cal EPA toxicity criteria. According to Cooke's presentation, USEPA is recommending that regulators manage risk within a range of 1 to 10 $\mu g/m^3$. The provisional guidance has not yet been officially published. USEPA Region I recommended using the Cal EPA toxicity criteria to develop the PRGs in this evaluation. Risks from trichloroethene that were estimated in this evaluation using the Cal EPA toxicity criteria were within USEPA and CTDEP acceptable levels for both residential and industrial exposures.

SUMMARY AND CONCLUSIONS

Site 2

Concentrations of chloroform, tetrachloroethene, and trichloroethene exceeded the USEPA screening criterion at Site 2. These chemicals were further evaluated using the Johnson and Ettinger Vapor Intrusion Model. Modeling results showed that cancer risks and hazard indices for residential and industrial scenarios were within USEPA and CTDEP acceptable levels at Site 2. Further evaluation against PRGs and ARARs showed that vapor intrusion is not an issue at Site 2. No further action is required for vapor intrusion issues.

Site 3

Concentrations of chloroform, trichloroethene, and vinyl chloride exceeded USEPA screening criterion at Site 3. Concentrations of vinyl chloride also exceed the residential CTDEP RSR for vapor intrusion at Site 3. These chemicals were further evaluated using the Johnson and Ettinger Vapor Intrusion Model. Modeling results showed that cancer risks and hazard indices for residential and industrial scenarios were within USEPA acceptable levels. Cancer risks for chloroform and vinyl chloride for residential exposures exceeded the CTDEP acceptable risk levels. Cancer risks for trichloroethene based upon Cal EPA toxicity criteria were within CTDEP acceptable levels for residential and industrial scenarios but cancer risks based upon draft EPA toxicity criteria exceeded CTDEP acceptable levels.

The maximum detected concentration of chloroform exceeds the site-specific PRG for residential exposures but is less than the site-specific PRG for industrial exposures, USEPA MCL, and the CTDEP RSRs for vapor intrusion for chloroform. Because the modeling only showed potential cancer risks exceeding CTDEP acceptable levels and the maximum concentration did not exceed the CTDEP RSRs for vapor intrusion, it is concluded that there are no vapor intrusion issues associated with chloroform and no further action is required.

The maximum detected concentration of trichloroethene exceeds the USEPA MCL but is less than the site-specific PRGs and CTDEP RSRs for vapor intrusion. A groundwater monitoring program and land use controls are in place to address the exceedance of the USEPA MCL for trichloroethene. No further action is required for vapor intrusion issues.

The maximum detected concentration of vinyl chloride exceeds the USEPA MCL, site-specific PRGs, and residential CTDEP RSR for vapor intrusion. A groundwater monitoring program and land use controls are in place to address the exceedance of the USEPA MCL for vinyl chloride. Considering the CTDEP RSRs for vapor intrusion, the vinyl chloride concentration detected in groundwater at monitoring well 2DMW29S does not represent a vapor intrusion issue under the current industrial scenario, but may be an issue under a future residential scenario. A building could be constructed in the vicinity of monitoring well 2DMW29S for industrial purposes; however, there would be restrictions on construction of a building within 100 feet of the well for residential use unless steps were taken to mitigate the vapor intrusion issue. The current Site 3 land use control document should be amended to include controls to address vapor intrusion issues at well 2DMW29S until groundwater concentrations are reduced to levels where vapor intrusion is no longer deemed an issue.

Site 7

Concentrations of trichloroethene exceeded the USEPA screening criterion at Site 7. Trichloroethene was further evaluated using the Johnson and Ettinger Vapor Intrusion Model. Modeling results showed that cancer risks and hazard indices for residential and industrial scenarios were within USEPA acceptable levels. Cancer risks based upon Cal EPA toxicity criteria were within CTDEP acceptable levels for residential but cancer risks based upon draft USEPA toxicity criteria exceeded CTDEP acceptable levels. Further evaluation against PRGs and ARARs showed that vapor intrusion is not an issue at Site 7. No further action is required for vapor intrusion issues.

Site 15

Concentrations of chloroform in one sample exceeded the USEPA screening criterion at Site 15. Chloroform was further evaluated using the Johnson and Ettinger Vapor Intrusion Model. Modeling results showed that cancer risks under a residential scenario were within USEPA acceptable levels but exceeded CTDEP acceptable levels. Cancer risks for an industrial scenario were within USEPA and CTDEP acceptable levels. Further evaluation against ARARs showed that vapor intrusion is not an issue at Site 15. No further action is required for vapor intrusion issues.

Site 20

Concentrations of trichloroethene exceeded the USEPA screening criterion at Site 20. Trichloroethene was further evaluated using the Johnson and Ettinger Vapor Intrusion Model. Modeling results showed that cancer risks based upon Cal EPA toxicity criteria were within USEPA and CTDEP acceptable levels for residential and industrial scenarios but cancer risks for a residential scenario based upon draft USEPA toxicity criteria exceeded CTDEP acceptable levels. Further evaluation against PRGs and ARARs showed that vapor intrusion is not an issue at Site 20. No further action is required for vapor intrusion issues.

Site 23

Concentrations of chloroform and trichloroethene exceeded the USEPA screening criterion at Site 23. Chloroform and trichloroethene were further evaluated using the Johnson and Ettinger Vapor Intrusion Model. Modeling results showed that cancer risks for chloroform under a residential scenario were within USEPA acceptable levels but exceeded CTDEP acceptable levels. Cancer risks for trichloroethene based upon Cal EPA toxicity criteria were within USEPA and CTDEP acceptable levels for residential and industrial scenarios but cancer risks for a residential scenario based upon draft USEPA toxicity criteria exceeded CTDEP acceptable levels. Further evaluation against ARARs showed that vapor intrusion is not an issue at Site 23. No further action is required for vapor intrusion issues.

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TABLE 1
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN AT SITE 2 - UPGRADIENT MONITORING WELLS
VAPOR INTRUSION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Upgradient Monitoring Wells (Site 2)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	USEPA Groundwater Volatilization Criteria(5)	CTDEP Groundwater Volatilization Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organic Compounds															
75-35-4	1,1-Dichloroethene	1	J	1	J	ug/L	2LGW20S-03	1/18	1	1	NA	190 N	190	No	BSL
67-64-1	Acetone	10	J	10	J	ug/L	4GW01S-10	1/15	5	10	NA	220000 N	50000	No	BSL
75-15-0	Carbon Disulfide	0.9	J	2		ug/L	4GW01S-10	1/18	1 - 2	2	NA	560 N	NA	No	BSL
67-66-3	Chloroform	1		1		ug/L	4GW01S-02	1/18	1 - 3	1	NA	0.71 C	26	Yes	ASL
74-87-3	Chloromethane	0.6	J	0.6	J	ug/L	4GW01S-09	1/18	1	0.6	NA	6.7 C	390	No	BSL
127-18-4	Tetrachloroethene	0.11	J	0.11	J	ug/L	4GW01S-05	1/18	1	0.11	NA	0.55 C	340	No	BSL
79-01-6	Trichloroethene	0.9	J	0.9	J	ug/L	4GW01S-08-D	1/18	1	0.9	NA	0.05 C	27	Yes	ASL

Notes:
Data is from the Year 3 Annual Groundwater Monitoring Report for Area A Landfill (Tetra Tech, 2003).
1 - Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - No background data is available for VOCs.
5 - Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils. November 2002. EPA530-F-02-052.
Values are from Table 2c and correspond to a target cancer risk level of 1E-6 or HI =1 and an attenuation factor of 0.001.
6 - Connecticut's Proposed Revisions Remediation Standard Regulations, Volatilization Criteria, Residential, March 2003.
7 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
8 - USEPA Region I target level.
A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

Associated Samples

2LGW20S-01	2LGW20S-11	4GW01S-07-D
2LGW20S-02	4GW01S-01	4GW01S-08
2LGW20S-02-D	4GW01S-01-D	4GW01S-08-D
2LGW20S-03	4GW01S-02	4GW01S-09
2LGW20S-04	4GW01S-03	4GW01S-09-D
2LGW20S-05	4GW01S-04	4GW01S-10
2LGW20S-06	4GW01S-05	4GW01S-10-D
2LGW20S-07	4GW01S-06	4GW01S-11
2LGW20S-08	4GW01S-06-D	4GW01S-11-D
2LGW20S-10	4GW01S-07	

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COPC = Chemical of Potential Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.
MCL = Federal Maximum Contaminant Level

Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BSL = Below COPC Screening Level/ARAR/TBC.

TABLE 2

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN AT SITE 2 - DOWNGRADIENT MONITORING WELLS IN AREA A DOWNSTREAM

VAPOR INTRUSION

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Downgradient Monitoring Wells in Area A Downstream (Site 2)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	USEPA Groundwater Volatilization Criteria(5)	CTDEP Groundwater Volatilization Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organic Compounds															
75-15-0	Carbon Disulfide	0.2	J	2.2		ug/L	3GW37S-08	2/17	1	2.2	NA	560 N	NA	No	BSL
156-59-2	cis-1,2-Dichloroethene	0.14	J	0.4	J	ug/L	3GW37S-03	5/17	1	0.4	NA	210 N	830	No	BSL
108-88-3	Toluene	0.1	J	0.1	J	ug/L	3GW37S-03	1/17	1	0.1	NA	1500 N	7100	No	BSL
156-60-5	trans-1,2-Dichloroethene	0.2	J	0.2	J	ug/L	3GW37S-03	1/17	1	0.2	NA	180 N	1000	No	BSL
79-01-6	Trichloroethene	0.58	J	2		ug/L	3GW37S-03	9/17	1	2	NA	0.05 C	27	Yes	ASL

Notes:
Data is from the Year 3 Annual Groundwater Monitoring Report for Area A Landfill (Tetra Tech, 2003).
1 - Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - No background data is available for VOCs.
5 - Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils. November 2002. EPA530-F-02-052.
Values are from Table 2c and correspond to a target cancer risk level of 1E-6 or HI =1 and an attenuation factor of 0.001.
6 - Connecticut's Proposed Revisions Remediation Standard Regulations, Volatilization Criteria, Residential, March 2003.
7 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
8 - USEPA Region I target level.
A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

Associated Samples

3GW-12D-01	3GW-12S-01	3GW37S-02	3GW37S-08
3GW-12D-01-D	3GW-12S-02	3GW37S-03	3GW37S-09
3GW-12D-02	3GW-12S-02-D	3GW37S-04	3GW37S-10
3GW-12D-03	3GW-12S-03	3GW37S-05	3GW37S-11
3GW-12D-03-3D	3GW-12S-03-D	3GW37S-06	3GW12D-11
3GW-12D-04	3GW37S-01	3GW37S-07	

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COPC = Chemical of Potential Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.
MCL = Federal Maximum Contaminant Level

Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BSL = Below COPC Screening Level/ARAR/TBC.

TABLE 3

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN AT SITE 2 - DOWNGRADIENT MONITORING WELLS IN AREA A WETLAND

VAPOR INTRUSION

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Downgradient Monitoring Wells In Area A Wetland (Site 2)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	USEPA Groundwater Volatilization Criteria(5)	CTDEP Groundwater Volatilization Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organic Compounds															
78-93-3	2-Butanone	1	J	26		ug/L	2WGW39DS-04	20/61	1 - 25	26	NA	440000 N	NA	No	BSL
67-64-1	Acetone	2	J	120		ug/L	2WGW39DS-04	26/79	5 - 31	120	NA	220000 N	50000	No	BSL
71-43-2	Benzene	0.2	J	0.3	J	ug/L	2WGW42DS-10	2/99	1 - 5	0.3	NA	1.36 C	130	No	BSL
75-15-0	Carbon Disulfide	0.2	J	7.6		ug/L	2WGW43DS-07	58/99	1 - 13	7.6	NA	560 N	NA	No	BSL
74-87-3	Chloromethane	0.8	J	0.8	J	ug/L	2WGW44DS-09	1/99	1 - 5	0.8	NA	6.7 C	390	No	BSL
100-41-4	Ethylbenzene	0.3	J	0.3	J	ug/L	2WGW39DS-04	1/99	1 - 5	0.3	NA	6.91 N(8)	2700	No	BSL
75-09-2	Methylene Chloride	0.5	J	1.2	J	ug/L	2WGW39DS-07	6/99	1 - 10	1.2	NA	58 C	160	No	BSL
127-18-4	Tetrachloroethene	0.3	J	1.4		ug/L	2WGW39DS-07	2/99	1 - 5	1.4	NA	0.55 C	340	Yes	ASL
108-88-3	Toluene	0.17	J	4		ug/L	2WGW39DS-03, 2WGW39DS-09	17/99	1 - 5	4	NA	1500 N	7100	No	BSL
1330-20-7	Total Xylenes	0.6	J	0.6	J	ug/L	2WGW42DS-09	1/89	1 - 5	0.6	NA	22000 N	8700	No	BSL
79-01-6	Trichloroethene	1.2		1.4		ug/L	2WGW46DS-07	2/99	1 - 5	1.4	NA	0.05 C	27	Yes	ASL

Notes:
Data is from the Year 3 Annual Groundwater Monitoring Report for Area A Landfill (Tetra Tech, 2003).
1 - Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - No background data is available for VOCs.
5 - Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils. November 2002. EPA530-F-02-052.
Values are from Table 2c and correspond to a target cancer risk level of 1E-6 or HI =1 and an attenuation factor of 0.001.
6 - Connecticut's Proposed Revisions Remediation Standard Regulations, Volatilization Criteria, Residential, March 2003.
7 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
8 - USEPA Region I target level.
A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COPC = Chemical of Potential Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.
MCL = Federal Maximum Contaminant Level

Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:

TABLE 4
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN AT SITE 3
VAPOR INTRUSION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Site 3

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	USEPA Groundwater Volatilization Criteria(5)	CTDEP Groundwater Volatilization Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organic Compounds															
79-34-5	1,1,2,2-Tetrachloroethane	0.33	J	0.33	J	ug/L	S3GW2DMW16D01	1/36	0.5 - 1	0.33	NA	3 C	1.8	No	BSL
75-27-4	Bromodichloromethane	0.5	J	1.8		ug/L	S3GW3MW16D01	4/36	0.5 - 1	1.8	NA	2.1 C	NA	No	BSL
124-48-1	Chlorodibromomethane	0.76		0.76		ug/L	S3GW3MW16D01	1/36	0.5 - 1	0.76	NA	3.2 C	NA	No	BSL
67-66-3	Chloroform	0.6	J	15		ug/L	S3GW3MW16S01	11/36	0.5 - 7.3	15	NA	0.71 C	26	Yes	ASL
156-59-2	cis-1,2-Dichloroethene	2		6		ug/L	S3GW2DMW29S02, S3GW2DMW29S02-D	11/36	0.5 - 1	6	NA	210 N	830	No	BSL
127-18-4	Tetrachloroethene	0.33	J	0.33	J	ug/L	S3GW3MW16S01	1/36	0.5 - 1	0.33	NA	0.55 C(8)	340	No	BSL
108-88-3	Toluene	0.33	J	51		ug/L	S3GW2DMW28D02	4/36	0.5 - 1	51	NA	1500 N	7100	No	BSL
1330-20-7	Total Xylenes	0.6	J	0.6	J	ug/L	S3GW2DMW28D02, S3GW2DMW28D03	2/36	0.5 - 1	0.6	NA	22000 N	8700	No	BSL
156-60-5	trans-1,2-Dichloroethene	0.33	J	0.5	J	ug/L	S3GW2DMW16S04	2/36	0.5 - 1	0.5	NA	180 N	1000	No	BSL
79-01-6	Trichloroethene	2		7		ug/L	S3GW2DMW16D02, S3GW2DMW16D03, S3GW2DMW16S04	8/36	0.5 - 1	7	NA	0.05 C	27	Yes	ASL
75-01-4	Vinyl Chloride	1.7		10		ug/L	S3GW2DMW29S02-D	3/36	0.5 - 1	10	NA	0.5 C	1.6	Yes	ASL

Notes:
Data is from the Year 1 Annual Groundwater Monitoring Report for Sites 3 and 7 (Tetra Tech, 2007).
1 - Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - No background data is available for VOCs.
5 - Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils. November 2002. EPA530-F-02-052.
Values are from Table 2c and correspond to a target cancer risk level of 1E-6 or HI =1 and an attenuation factor of 0.001.
6 - Connecticut's Proposed Revisions Remediation Standard Regulations, Volatilization Criteria, Residential, March 2003.
7 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
8 - USEPA Region I target level.
A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COPC = Chemical of Potential Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.
MCL = Federal Maximum Contaminant Level

Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BSL = Below COPC Screening Level/ARAR/TBC.

Associated Samples

S3GW2DMW16D01
S3GW2DMW16D02
S3GW2DMW16D03
S3GW2DMW16D04
S3GW2DMW16S01
S3GW2DMW16S02
S3GW2DMW16S03
S3GW2DMW16S04
S3GW2DMW25S01
S3GW2DMW25S02
S3GW2DMW25S03
S3GW2DMW25S04
S3GW2MW28D01
S3GW2DMW28D02
S3GW2DMW28D03
S3GW2DMW28D04
S3GW2DMW29S01
S3GW2DMW29S02
S3GW2DMW29S03
S3GW2DMW29S04
S3GW3MW15I01
S3GW3MW15I02
S3GW3MW15I03
S3GW3MW15I04
S3GW3MW15S01
S3GW3MW15S02
S3GW3MW15S03
S3GW3MW15S04
S3GW3MW16D01
S3GW3MW16D02
S3GW3MW16D03
S3GW3MW16D04
S3GW3MW16S01
S3GW3MW16S02
S3GW3MW16S03
S3GW3MW16S04

TABLE 5
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN AT SITE 7
VAPOR INTRUSION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Site 7

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	USEPA Groundwater Volatilization Criteria(5)	CTDEP Groundwater Volatilization Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organic Compounds															
76-13-1	1,1,2-Trichlorotrifluoroethane	0.58		0.58		ug/L	S7GW7MW12I01	1/7	0.5	0.58	NA	1500 N	NA	No	BSL
75-34-3	1,1-Dichloroethane	0.32	J	0.77		ug/L	S7GW7MW12I01	5/28	0.5 - 1	0.77	NA	2200 N	3000	No	BSL
108-90-7	Chlorobenzene	1	J	2		ug/L	S7GW7MW12S03, S7GW7MW12S04	4/28	0.5 - 1	2	NA	390 N	1800	No	BSL
156-59-2	cis-1,2-Dichloroethene	0.32	J	0.6	J	ug/L	S7GW7MW12S03, S7GW7MW12I01	3/28	0.5 - 1	0.6	NA	210 N	830	No	BSL
156-60-5	trans-1,2-Dichloroethene	1	J	1	J	ug/L	S7GW7MW12I03	1/28	0.5 - 1	1	NA	180 N	1000	No	BSL
79-01-6	Trichloroethene	0.7	J	1		ug/L	S7GW7MW5D02, S7GW7MW5D03, S7GW7MW12I03	8/28	0.5 - 1	1	NA	0.05 C	27	Yes	ASL

Notes:
Data is from the Year 1 Annual Groundwater Monitoring Report for Sites 3 and 7 (Tetra Tech, 2007).
1 - Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - No background data is available for VOCs.
5 - Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils. November 2002. EPA530-F-02-052.
Values are from Table 2c and correspond to a target cancer risk level of 1E-6 or HI =1 and an attenuation factor of 0.001.
6 - Connecticut's Proposed Revisions Remediation Standard Regulations, Volatilization Criteria, Residential, March 2003.
7 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
8 - USEPA Region I target level.
A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC.

Associated Samples

S7GW7MW1D01	S7GW7MW5D03
S7GW7MW1D02	S7GW7MW5D04
S7GW7MW1D03	S7GW7MW9S01
S7GW7MW1D04	S7GW7MW9S02
S7GW7MW3I01	S7GW7MW9S03
S7GW7MW3I02	S7GW7MW9S04
S7GW7MW3I03	S7GW7MW12I01
S7GW7MW3I04	S7GW7MW12I02
S7GW7MW3S01	S7GW7MW12I03
S7GW7MW3S02	S7GW7MW12I04
S7GW7MW3S03	S7GW7MW12S01
S7GW7MW3S04	S7GW7MW12S02
S7GW7MW5D01	S7GW7MW12S03
S7GW7MW5D02	S7GW7MW12S04

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COPC = Chemical of Potential Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.
MCL = Federal Maximum Contaminant Level

Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BSL = Below COPC Screening Level/ARAR/TBC.

TABLE 6
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN AT SITE 15
VAPOR INTRUSION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Site 15

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	USEPA Groundwater Volatilization Criteria(5)	CTDEP Groundwater Volatilization Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organic Compounds															
67-66-3	Chloroform	3		3		UG/L	S15GW15TW301	1/6	1	3	N/A	0.71 N	26	Yes	ASL

Notes:
Data is from the Basewide Groundwater Operable Unit Remedial Investigation Report Update/Feasibility Study Report (Tetra Tech, 2004).
1 - Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - No background data is available for VOCs.
5 - Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils. November 2002. EPA530-F-02-052.
Values are from Table 2c and correspond to a target cancer risk level of 1E-6 or HI =1 and an attenuation factor of 0.001.
6 - Connecticut's Proposed Revisions Remediation Standard Regulations, Volatilization Criteria, March 2003.
7 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
8 - USEPA Region I target level.
A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

Associated Samples:
S15GW15MW1S02
S15GW15MW2S02
S15GW15MW2S02-D
S15GW15MW3S02
S15GW15TW101
S15GW15TW201
S15GW15TW301

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COPC = Chemical of Potential Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.
MCL = Federal Maximum Contaminant Level

Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BSL = Below COPC Screening Level/ARAR/TBC.

TABLE 7
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN AT SITE 20
VAPOR INTRUSION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Area A Weapons Center (Site 20)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	USEPA Groundwater Volatilization Criteria(5)	CTDEP Groundwater Volatilization Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organic Compounds															
108-10-1	4-Methyl-2-Pentanone	1.29	J	1.29	J	ug/L	S202WCMW2S01	1/4	5	1.29	N/A	14000 N	13000	No	NTX
79-01-6	Trichloroethene	3.8	J	5.02	J	ug/L	S202WCMW2S01	2/4	1	5.02	N/A	0.05 C	27	Yes	ASL

Notes:
Data is from the Basewide Groundwater Operable Unit Remedial Investigation Report (Tetra Tech, 2001).
1 - Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - No background data is available for VOCs.
5 - Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils. November 2002. EPA530-F-02-052.
Values are from Table 2c and correspond to a target cancer risk level of 1E-6 or HI =1 and an attenuation factor of 0.001.
6 - Connecticut's Proposed Revisions Remediation Standard Regulations, Volatilization Criteria, March 2003.
7 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
8 - USEPA Region I target level.
A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

Associated Samples:
S202WCMW1S01
S202WCMW2S01
S202WCMW3S01
S202WMW4D01

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COPC = Chemical of Potential Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.

Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BSL = Below COPC Screening Level/ARAR/TBC.
NTX = No Toxicity Information.

TABLE 8
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN AT SITE 23 - UNDERDRAIN METERING PIT
VAPOR INTRUSION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Underdrain Metering Pit (Site 23)

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Concentration Used for Screening(3)	Background Value(4)	USEPA Groundwater Volatilization Criteria(5)	CTDEP Groundwater Volatilization Criteria(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organic Compounds															
71-43-2	Benzene	0.2	J	0.2	J	ug/L	S23GWMPM04	1/4	0.5	0.2	NA	1.4 C(8)	130	No	BSL
75-27-4	Bromodichloromethane	0.3	J	0.3	J	ug/L	S23GWMPM01	1/4	0.5	0.3	NA	2.1 C	2.3	No	BSL
110-82-7	Cyclohexane	0.1	J	0.1	J	ug/L	S23GWMPM02	1/4	0.5	0.1	NA	NA	NA	No	NTX
67-66-3	Chloroform	2	J	3	J	ug/L	S23GWMPM01	1/4	0.5	3	NA	0.71 C	26	Yes	ASL
156-59-2	cis-1,2-Dichloroethene	0.2	J	0.3	J	ug/L	S23GWMPM01, S23GWMPM02	4/4	0.5	0.3	NA	210 N	830	No	BSL
98-82-8	Isopropylbenzene	0.09	J	0.1	J	ug/L	S23GWMPM01, S23GWMPM02	2/4	0.5	0.1	NA	8.4 N	NA	No	BSL
1634-04-4	Methyl Tert-Butyl Ether	0.4	J	1		ug/L	S23GWMPM01	4/4	--	1	NA	120000 N	21000	No	BSL
127-18-4	Tetrachloroethene	0.2	J	0.4	J	ug/L	S23GWMPM02	4/4	--	0.4	NA	0.55 C(8)	340	No	BSL
79-01-6	Trichloroethene	0.3	J	0.5	J	ug/L	S23GWMPM02	4/4	--	0.5	NA	0.05 C	27	Yes	ASL

Notes:
Data is from the Year 1 Annual Monitoring Report for Site 23 Underdrain Metering Pit (Tetra Tech, 2008).
1 - Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - No background data is available for VOCs.
5 - Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils. November 2002. EPA530-F-02-052.
Values are from Table 2c and correspond to a target cancer risk level of 1E-6 or HI =1 and an attenuation factor of 0.001.
6 - Connecticut's Proposed Revisions Remediation Standard Regulations, Volatilization Criteria, Residential, March 2003.
7 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level and/or an ARAR/TBC(s).
8 - USEPA Region I target level.
A shaded value indicates that the concentration used for screening exceeds the criterion or background value.
A shaded chemical name indicates that the chemical has been selected as a COPC .

Associated Samples
S23GWMPM01
S23GWMPM01-D
S23GWMPM02
S23GWMPM-03
S23GWMPM02-D
S23GWMPM04

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
C = Carcinogen.
COPC = Chemical of Potential Concern.
J = Estimated Value.
N = Noncarcinogen.
NA = Not Applicable.
MCL = Federal Maximum Contaminant Level

Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level/ARAR/TBC.

For Elimination as a COPC:
BSL = Below COPC Screening Level/ARAR/TBC.
NTX = No toxicity criteria available.

TABLE 9
INPUT PARAMETERS FOR THE VAPOR INTRUSION MODEL
NSB-NLON, GROTON, CONNECTICUT

Site and Well	Depth to Groundwater (feet bgs)	Depth to Groundwater Used in Model	Soil Type	Soil Type Used in Model	Dry Bulk Density (gm/cm^3)	Total Porosity	Screened Interval (feet bgs)	Reference
2								
Upgradient								
4MW01S	6.3 to 9.9	6.3 feet (190 cm)	Bedrock w/ gravel and silty sand above	Sandy Loam (SL)	1.8	0.33	8 to 18	Year 3 GMR for Area A Landfill, Rounds 9 through 11, 12/2002 to 9/2002
Downstream								
3MW37S	3.61 to 3.79	3.6 feet (110 cm)	Silty Sand w/ trace rock fragments	Sandy Loam (SL)	1.8	0.33	4.5 to 5.5	Year 3 GMR for Area A Landfill, Rounds 9 through 11, 12/2002 to 9/2002
Wetlands								
2WMW39DS	2.4 to 3.4	2.1 feet (65 cm)	Org. Clayey Silt	Clay Loam (CL)	Default	Default	4 to 14	Year 3 GMR for Area A Landfill, Rounds 9 through 11, 12/2002 to 9/2002
2WMW46DS	1.55 to 2.28		Org. Clayey Silt		Default	Default	4 to 14	Year 3 GMR for Area A Landfill, Rounds 9 through 11, 12/2002 to 9/2002
3								
3MW15I	30.9	3.6 feet (110 cm)	Sand and Gravel	Sand (S)	1.8	0.33	55 to 65	Rnd 4, Year 1 GMR for Sites 3 and 7
3MW15S	29.4		Sand and Gravel		1.8	0.33	28 to 38	Rnd 4, Year 1 GMR for Sites 3 and 7
3MW16D	22.1		Bedrock w/ sand and cobbles above		1.8	0.33	59 to 69	Rnd 4, Year 1 GMR for Sites 3 and 7
3MW16S	14.4		Bedrock w/ sand and cobbles above		1.8	0.33	17 to 27	Rnd 4, Year 1 GMR for Sites 3 and 7
2DMW16D	3.7		Bedrock w/ sand, silt, and cobbles above		1.8	0.33	18 to 60	Rnd 4, Year 1 GMR for Sites 3 and 7
2DMW29S	8.6		Sand		1.8	0.33	6 to 16	Rnd 4, Year 1 GMR for Sites 3 and 7
7								
7MW05D	12.4	5 feet (150 cm)	Bedrock w/ silty sand w/ trace gravel above	Loamy Sand (LS)	1.6	0.37	32 to 42	Rnd 4, Year 1 GMR for Sites 3 and 7
7MW12I	5		Sandy silt		1.6	0.37	20 to 30	Rnd 4, Year 1 GMR for Sites 3 and 7
15								
15TW03	6.5	6.5 feet (200 cm)	Sandy silt	Loamy Sand (LS)	1.5	0.45	5 to 15	BGOURI Update/FS
20								
2WCMW2S	4.6	4.6 feet (140 cm)	Silty sand w/ granite fragments	Sandy Loam (SL)	1.6	0.37	4 to 14	BGOURI Update/FS
2WCMW4D	6.1		Bedrock		1.6	0.37	13 to 119	BGOURI Update/FS
23								
23MP01	7 to 9	7 feet (210 cm)	Silty sand	Sandy Loam (SL)	1.5	0.45	HNUS 23 (7 to 17)	BGOURI

Other Information

Site	Bulk Density (lb/cf)	Bulk Density (g/cm^3)	Porosity	Reference
3	112.22	1.8	0.3306	BGOURI
7	98.77	1.6	0.374	BGOURI
23	90.8	1.5	0.445	BGOURI

TABLE 10
NON-CANCER TOXICITY DATA -- INHALATION
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Extrapolated RfD[1]		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfC : Target Organ(s)	
		Value	Units	Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Volatile Organic Compounds									
Chloroform	Chronic	4.9E-02	mg/m^3	1.4E-02	(mg/kg/day)	Liver	NA	USEPA III	10/11/2007
Tetrachloroethene	Chronic	2.8E-01	mg/m^3	8.0E-02	(mg/kg/day)	Liver	NA	USEPA III	10/11/2007
Trichloroethene - Draft EPA	Chronic	3.5E-02	mg/m^3	1.0E-02	(mg/kg/day)	Liver, CNS	NA	USEPA(1)	8/2001
Trichloroethene - Cal EPA	Chronic	6.0E-01	mg/m3	1.7E-01	(mg/kg/day)	Liver, CNS	NA	CA EPA	12/2002
Vinyl Chloride	Chronic	1.0E-01	mg/m^3	2.9E-02	(mg/kg/day)	Liver	30/1	IRIS	5/02/2008

Notes:

1 - Extrapolated RfD = RfC *$20m^3$/day / 70 kg

Definitions:

CNS = Central Nervous System

EPA III = U.S. EPA Region 3 RBC Table, October 11, 2007.

IRIS = Integrated Risk Information System

NA = Not available.

USEPA(1) = Draft Trichloroethylene Health Risk Assessment: Synthesis and Characterization, August 2001.

Cal EPA = California EPA, Technical Support Document for Describing Available Cancer Potency Factors, December 2002.

TABLE 11
CANCER TOXICITY DATA -- INHALATION
NSB-NLON, GROTON, CONNECTICUT

Chemical of Potential Concern	Unit Risk		Inhalation Cancer Slope Factor[1]		Weight of Evidence/ Cancer Guideline Description	Unit Risk : Inhalation CSF	
	Value	Units	Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Volatile Organic Compounds							
Chloroform	2.3E-05	$(ug/m^3)^{-1}$	8.1E-02	$(mg/kg/day)^{-1}$	B2	IRIS	5/02/2008
Tetrachloroethene	5.9E-06	$(ug/m^3)^{-1}$	2.1E-02	$(mg/kg/day)^{-1}$	NA	USEPA(1)	6/12/2003
Trichloroethene - Draft EPA	1.1E-04	$(ug/m^3)^{-1}$	4.0E-01	$(mg/kg/day)^{-1}$	C	USEPA(2)	8/2001
Trichloroethene - Cal EPA	2.0E-06	(ug/m3)-1	7.0E-03	(mg/kg/day)-1	C	CA EPA	12/2002
Vinyl Chloride (adult)	4.4E-06	$(ug/m^3)^{-1}$	1.5E-02	$(mg/kg/day)^{-1}$	A	IRIS	5/02/2008

Notes:
1 - Inhalation CSF = Unit Risk * 70 kg / $20m^3$/day.

Definitions:
IRIS = Integrated Risk Information System.
NA = Not Available.
USEPA(1) = OSWER Directive No.9285.7-75.
USEPA(2) = Draft Trichloroethylene Health Risk Assessment: Synthesis and Characterization, August 2001.

EPA Group:
A - Human carcinogen.
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans .
C - Possible human carcinogen.

TABLE 12
SUMMARY OF VAPOR INTRUSION MODELING RESULTS
NSB-NLON, GROTON, CONNECTICUT

Chemical	Site 2 - Area A - Upgradient			Site 2 - Area A - Downstream			Site 2 - Area A - Wetlands		
	EPC (ug/L)	Cancer Risk	Hazard Index	EPC (ug/L)	Cancer Risk	Hazard Index	EPC (ug/L)	Cancer Risk	Hazard Index
	Residential			Residential			Residential		
Chloroform	1	5E-08	1E-04	NA	NA	NA	NA	NA	NA
Tetrachloroethene	NA	NA	NA	NA	NA	NA	1.4	8E-08	1E-04
Trichloroethene - EPA Toxicity Criteria	0.9	2E-07	1E-04	2	4E-07	3E-04	1.4	1E-06	6E-04
Trichloroethene - Cal EPA Toxicity Criteria	0.9	3E-09	7E-06	2	8E-09	2E-05	1.4	2E-08	4E-05
Vinyl Chloride	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Industrial			Industrial			Industrial		
Chloroform	1	7E-09	2E-05	NA	NA	NA	NA	NA	NA
Tetrachloroethene	NA	NA	NA	NA	NA	NA	1.4	1E-08	2E-05
Trichloroethene - EPA Toxicity Criteria	0.9	2E-08	1E-05	2	6E-08	5E-05	1.4	2E-07	1E-04
Trichloroethene - Cal EPA Toxicity Criteria	0.9	5E-10	1E-06	2	1E-09	3E-06	1.4	3E-09	6E-06
Vinyl Chloride	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
NA - Not a COPC at this site.
EPC = Exposure point concentration, maximum detected concentration of a chemical at a site.
Shading indicates an exceedance of USEPA and/or CTDEP acceptable risk levels.

TABLE 12
SUMMARY OF VAPOR INTRUSION MODELING RESULTS
NSB-NLON, GROTON, CONNECTICUT

Chemical	Site 3			Site 7			Site 15		
	EPC (ug/L)	Cancer Risk	Hazard Index	EPC (ug/L)	Cancer Risk	Hazard Index	EPC (ug/L)	Cancer Risk	Hazard Index
	Residential			Residential			Residential		
Chloroform	15	7E-06	1E-02	NA	NA	NA	3	4E-06	7E-03
Tetrachloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene - EPA Toxicity Criteria	7	3E-05	2E-02	1	2E-06	1E-03	NA	NA	NA
Trichloroethene - Cal EPA Toxicity Criteria	7	6E-07	1E-03	1	4E-08	8E-05	NA	NA	NA
Vinyl Chloride	10	8E-06	4E-02	NA	NA	NA	NA	NA	NA
	Industrial			Industrial			Industrial		
Chloroform	15	1E-06	3E-03	NA	NA	NA	3	5E-07	1E-03
Tetrachloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethene - EPA Toxicity Criteria	7	5E-06	3E-03	1	3E-07	2E-04	NA	NA	NA
Trichloroethene - Cal EPA Toxicity Criteria	7	8E-08	2E-04	1	6E-09	1E-05	NA	NA	NA
Vinyl Chloride	10	1E-06	7E-03	NA	NA	NA	NA	NA	NA

Notes:
NA - Not a COPC at this site.
EPC = Exposure point concentration, maximum detected concentration of a chemical at a site.
Shading indicates an exceedance of USEPA and/or CTDEP acceptable risk levels.

TABLE 12
SUMMARY OF VAPOR INTRUSION MODELING RESULTS
NSB-NLON, GROTON, CONNECTICUT

Chemical	Site 20			Site 23		
	EPC (ug/L)	Cancer Risk	Hazard Index	EPC (ug/L)	Cancer Risk	Hazard Index
	Residential			Residential		
Chloroform	NA	NA	NA	3	2E-06	5E-03
Tetrachloroethene	NA	NA	NA	NA	NA	NA
Trichloroethene - EPA Toxicity Criteria	5.02	4E-06	2E-03	0.5	4E-06	2E-03
Trichloroethene - Cal EPA Toxicity Criteria	5.02	7E-08	1E-04	0.5	7E-08	1E-04
Vinyl Chloride	NA	NA	NA	NA	NA	NA
	Industrial			Industrial		
Chloroform	NA	NA	NA	3	3E-07	8E-04
Tetrachloroethene	NA	NA	NA	NA	NA	NA
Trichloroethene - EPA Toxicity Criteria	5.02	6E-07	4E-04	0.5	5E-07	4E-04
Trichloroethene - Cal EPA Toxicity Criteria	5.02	1E-08	3E-05	0.5	1E-08	2E-05
Vinyl Chloride	NA	NA	NA	NA	NA	NA

Notes:
NA - Not a COPC at this site.
EPC = Exposure point concentration, maximum detected concentration of a chemical at a site.
Shading indicates an exceedance of USEPA and/or CTDEP acceptable risk levels.

TABLE 13
PRELIMINARY REMEDIATION GOALS AND OTHER ARARs FOR VAPOR INTRUSION
NSB-NLON, GROTON, CONNECTICUT

Chemical	EPC[1] (ug/L)	PRG[2]		USEPA MCL[3]	CTDEP RSR[4]	
		Residential	Industrial		Residential	Industrial
Site 2 - Area A - Upgradient						
Chloroform	1	21	144	80[5]	26	62
Trichloroethene[6]	0.9	258	1769	5	27	67
Site 2 - Area A - Downgradient						
Trichloroethene	2	257	1760	5	27	67
Site 2 - Area A - Wetlands						
Tetrachloroethene	1.4	18	122	5	340	810
Trichloroethene[6]	1.4	74	508	5	27	67
Site 3						
Chloroform	15	2.1	15	80[3]	26	62
Trichloroethene[6]	7	12	85	5	27	67
Vinyl Chloride	10	1.3	8.6	2	1.6	52
Site 7						
Trichloroethene[6]	1	24	163	5	27	67
Site 15						
Chloroform	3	0.9	5.9	80[3]	26	62
Site 20						
Trichloroethene[6]	5.02	68	467	5	27	67
Site 23						
Chloroform	3	1.3	9.1	80[3]	26	62
Trichloroethene[6]	0.5	7.5	52	5	27	67

Acronyms:
ARARs = Applicable or Relevant and Appropriate Regulations
EPC = Exposure Point Concentration.
MCL = Maximum contaminant level.
PRG = Preliminary Remediation Goal
RSR = Remediation Standard Regulations.

Notes:
All concentrations are in ug/L.
1 - EPC is the maximum detected concentration at a site.
2 - PRGs are based on a cancer risk of 1 x 10^{-6} or an hazard index of 1.
3 - USEPA Drinking Water Standards and Health Advisories, August 2006.
4 - Proposed Revisions - Connecticut's Remediation Standard Regulations, Volatilization Criteria, March 2003.
5 - Value is for total trihalomethanes.
6 - PRG for trichloroethene is calculated using the Cal EPA toxicity criteria.
Shading indicates an exceedance of a PRG or ARAR.

ATTACHMENT A

BORING LOGS AND

DEPTH TO GROUNDWATER INFORMATION

BORING LOG

HALLIBURTON NUS

PROJECT: NSB-NLON
BORING NO.: 4MW1S
PROJECT NO.: 9594
DATE: 02-03-94
DRILLER: EAST COAST THOMAS / Tim Sabo
ELEVATION:
FIELD GEOLOGIST: Tim Evans
WATER LEVEL DATA:
(Date, Time & Conditions)

	SAMPLE NO. & TYPE OR RQD	DEPTH (FT.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY / SAMPLE LENGTH	LITHOLOGY CHANGE (Depth/Ft.)	MATERIAL DESCRIPTION* SOIL DENSITY/CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS OVM	
	S-1 @	0.0	15 / 15	1.5/2.0		Dense	Black to	Gravel w/Tr Sand	GP	Roadbed Wet 0ppm	
	1438	2.0	20 / 15				Gray			Sand - fn to C Gr Gravel - Pebble Greenstone	
1523	S-2 @		15 / 22	1.1/1.8	BR@2.5'	V.Dense	Tan	Clayey Sand w/Tr Gravel/	SC/	Wet 0ppm	
	1452 4.0		62 / 100/5					Silty Sand w/Tr Gravel	SW	Sand - fn to C Gr Gravel - Gneiss Max 0.3'	
	3.25/5.0	(1)	65%	4.5/5.0		Hard	Gray to	Gneiss	BR	Fe stained Gravel - Pebbles	
1931 2/3 0815 2/4							Pink	Hi ∠ JNT @ 2.5' 2.8'	*	SS Refusal. Move 1' SW.	
0830	7.0							w/ sand seams in jnts 3.3' 5.2	[illegible]	Lo ∠ Frac @ 5.0' 7.0' 5.5'	
	.75/1.5	(2)		1.4/1.5		Hard	Gray to	Gneiss w/sand seams	Br	Lo ∠ Frac @ 7.2', 8.0' Hi ∠ JNT 7.5', 7.6'	
1030 1320	8.5						cream				
										Lo ∠ Frac @ 12.4', 9.9', 11.5'	
										Core Barrel Break @ 8.6', 8.75', 9.1'	
	4.0/5.0	(3)	80%	5.0/5.0		Hard	Gray to	Gneiss	VBr Br	10.0', 13.3'	
							pink				
1610 2/4 0951 2/7	13.5								M	Pump H_2O out to 13.5' Recharge to 6' w/in 30"	2/4
										H_2O level @ 2.1'	2/7
	3.9/5.0	(4)	75%	4.8/5.0		Hard	Gray to	Gneiss	VBR	Lo ∠ Frac @ 15.1' 15.2'	
							White		Br	15.5'	
										16.0'	
										Hi ∠ JNT @ 16.5'/17.2' 15.3'	
1247	18.5									16.5' 16.9'	
								Total Depth 18.5'		Core Barrel Break @ 17.4'	
								Screen 8.5'-18.5' →		2" PVC 0.010 Slot	
								Sand 6'-18.5' →		~100# Bag [illegible] Sand	
								Pellets 3'-6' →		~58# Bag Bentonite [illegible]	

REMARKS Gemco GT 350 HSA Rig ATV
3" x 24" SS (140# wt, Cat Head, 30" Drop)
4" Temp Steel Casing w/ Spin Cutter Head 0' to 8.5'
HQ (3½" OD) Core 2.5' to 18.5'
3⅞" ϕ Roller bit 0' to 2.5'

BORING 4MW1S

PAGE 1 OF 1

* See Legend on Back

000001

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSB-NLON
PROJECT NUMBER: 5082
DRILLING COMPANY: EDI, Inc.
DRILLING RIG: Tripod
BORING NUMBER: 3MW37S
DATE: 5-19-99
GEOLOGIST: T. Evans
DRILLER: A. Orlicky

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ**
	0.0								Time				
S-1		3 / 2	0.7/2.0			Dk Brn	Humus	Pt	1330 Wet	0	0		0
	2.0	5 / 1		~2.0'									
* S-2		8 / 15	1.3/2.0		V Dense	Tan Brn	Silty F SAND	SP	1352	0	0		0
	4.0	37 / 46					Tr Rock Frags		Refusal @ 4'				
									~~Ledge~~ BR				
	6.0			5.5					5/20 @ 1210				
									Drive 4" temp				
									casing to 5' @ location				
							set 1' screen (10 slot)		4.5-5.5 ~2' NE				
							Valve #1 Sand		3.5-5.5				
							Bentonite		2.5-3.5				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): Ø

Remarks: 3" SS ; ~ 20 yds west of Seep
* sample

Converted to Well: Yes ✓ No ____ Well I.D. #: 3MW37S

Tetra Tech NUS, Inc.

BORING LOG

Page 1 of ___

PROJECT NAME:	NSB-NLON	BORING NUMBER:	2WMW39DS
PROJECT NUMBER:	5082	DATE:	5-18-99
DRILLING COMPANY:	EDI, Inc.	GEOLOGIST:	T. Evans
DRILLING RIG:	Tripod w/ Cathead	DRILLER:	A. Orlicky

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	0.0								Time				
S-1		2/3	1.5/2.0	0.4	Loose	Brn	Silt some F Sand / M-C Sand	ML / SP	1340 Photo#	0	0		0
	2.0	2/4							Saturated				
S-2		3/3	0.5/2.0		Loose	DBrn	F-C Sand	SW	1345	0	0		0
	4.0	3/3											
S-3			0.0/2.0				No Recovery		1348	0	0		0
	6.0												
S-4		7/4	0.4/2.0		M Stiff		Poor Recovery		1420	—			
	8.0	3/3	[illegible]			olive brn	Clayey Silt in Shoe	OH					
S-5		4/3	1.1/2.0		M Stiff	olive brn	Clayey Silt	OH	1445	37.8			
	10.0	3/2					Tr Shell						
S-6		1/2	1.8/2.0		Soft				1505 722	[illegible]	0		0
	12.0	2/1											
S-7		4/2	2.0/2.0		Soft				1513	111	0		0
	14.0	3/1											
S-8		5/4	2.0/2.0		M Stiff				1520	29.9			
	16.0	4/3											
				EOB 16					Drive 4'				
									temp casing				
									to 15'				
							2" PVC 4-14		1600				
							#0 Sand 3-15		Let well				
							Bentonite 2-3						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 0

Remarks: 3" SS
* Sample 2W-SL-39DS-00-99

Converted to Well: Yes ______ No ______ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSB-NLON
PROJECT NUMBER: 5082
DRILLING COMPANY: EDI, Inc.
DRILLING RIG: Tripod w/cat head

BORING NUMBER: 2WMW46DS
DATE: 5-17-99
GEOLOGIST: T. Evans
DRILLER: A. Orlicky

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ**
	0.0								Time				
S-1		13 / 8	0.9/2.0		-	Brn	Root matter	PT	0949	0.0			0.0
	2.0	6 / 6							wet				
S-2		4 / 7	0.0/2.0		-		No Recovery	-	1000	—			
	4.0	6 / 3											
* S-3		4 / 2	1.0/2.0		V Soft	olive brn-gray	Organic Clayey Silt	OH	1020	8.0	0.0		0.0
	6.0	1 / 1											
S-4		2 / 1	2.0/2.0		M Stiff	olive brn	Organic Clayey Silt	OH	1030	123	0.0		0.0
	8.0	2 / 3											
S-5		2 / 2	2.0/2.0		Soft	olive brn	Organic Clayey Silt Tr Roots (Remnant)	OH	1040 H2S odor Drive 4" temp Casing	33.0			
	10.0	2 / 2											
S-6		2 / 2	2.0/2.0		M Stiff	olive brn	Organic Clayey Silt	OH	1100 H2S odor	99.4	0.0		0.0
	12.0	2 / 3											
S-7		4 / 3	2.0/2.0		M Stiff	olive brn	Organic Clayey Silt Tr Shell	OH	1125	124	0.0		0.0
	14.0	2 / 3											
S-8		5 / 3	2.0/2.0		Soft	↓	↓	↓	1130	132	0.0		0.0
	16.0	2 / 1											
									4" Temp Casing to 15'				
							2" PVC 6-Slot	4-14'					
							Valve #0 Sand	3'-15'					
							Bentonite 2-3'						
							Protective Casing		2.5' Stickup				
									1240 Ends				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 2" SS
* Sample 2W-SU-46DS-04-99

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ✓ No ____ Well I.D. #: 2WMW46DS

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSB New London, CT Site 3
BORING No.: 3MW15I
PROJECT NUMBER: CTO 038, G00083
DATE: 4/27/06
DRILLING COMPANY: New England Boring Contractors
GEOLOGIST: Colin Doolan
DRILLING RIG: Mobile B59 Drill
DRILLER: S. Ramsdell

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ**
	0												
S-1 0905		2 / 3	.6 / 2		loose	brown	organic silt and	SM	2 ft. fill	0			
	2	6 / 7					fine sand, some med. sand.	SM	damp	0			
							(fill)						
	5												
S-2 0920		26 / 83	.5 / 2		loose	tan to	rock fragments,	GP	refusal after 1st foot of	0			
	7					light grey	gravel, pebbles, cobbles		spoon				
									damp to dry				
	10												
S-3 0944		41 / 63	1 / 2		loose	brown orange	cobbles, pebbles, gravel	GP	damp	0			
	12	33 / 44				brown and	and coarse sand, with some fine sand	GP		0			
						grey							
	15												
S-4 1000		15 / 12	1 / 2		loose	tan	gravel and sand	GP	moist	0			
	17	22 / 20				to light	some pebbles	GP		0			
						brown							
	20												
S-5 1015		8 / 11	1.3 / 2		loose	light brown	sand, well sorted	SM	v. moist to	0			
	22	9 / 9					med. sand	SM	wet	0			
	25												

* When rock coring, enter rock brokeness.
** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 4 1/4" ID augers, 2' split spoons

Drilling Area Background (ppm): 0

Converted to Well: Yes X No ____ Well I.D. #: 3MW15I

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSB New London, CT Site 3
BORING No.: 3MW15I
PROJECT NUMBER: CTO 038, G00083
DATE: 4/27/06 - 5/2/06
DRILLING COMPANY: New England Boring Contractors
GEOLOGIST: Colin Doolan
DRILLING RIG: Mobile B59 Drill
DRILLER: S. Ramsdell

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ
	25												
S-6 1025		5 / 7	2 / 2		loose	light brown	med. sand well sorted	SM	moist	0			
	27	9 / 13						SM		0			
	30												
S-7 1035		4 / 7	2 / 2	30.5'	loose	brown	coarse sand well sorted	SM	saturated	0			
	32	7 / 9			med dense		fine sand to silt	SM		0			
									water table: 30.5'				
	35												
S-8 1100		6 / 9	2 / 2		loose to med dense	brown	very fine sand	SM	saturated	0			
	37	12 / 12						SM		0			
	40												
S-9 1110		4 / 9	2 / 2		med dense	brown	fine to v. fine sand and silt	SM		0			
	42	12 / 16						SM		0			
	45												
S-10 1130		7 / 9	2 / 2		med dense	brown	very fine sand with some silt	SM		0			
	47	13 / 17						SM		0			
	50												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes X No ____ Well I.D. #: 3MW15I

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME:	NSB New London, CT Site 3	BORING No.:	3MW15I
PROJECT NUMBER:	CTO 038, G00083	DATE:	4/27/06 - 5/2/06
DRILLING COMPANY:	New England Boring Contractors	GEOLOGIST:	Colin Doolan
DRILLING RIG:	Mobile B59 Drill	DRILLER:	S Ramsdell

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ
	50												
S-11 1159		8 / 9	1.5 / 2		med dense	brown	fine sand	SM	saturated	0			
	52	12 / 14					well sorted	SM		0			
	55												
S-12 1210		7 / 10	1.5 / 2		med dense	brown	fine to v. fine sand w/some silt	SM		0			
	57	10 / 11						SM		0			
	60												
S-13 @ 1030		11 / 29	1.5/2		V DENSE	BRN	SILTY F SAND	SM	WET	0			
	62	31 / 37		61.5	V. DENSE	BRN	FINE/MED SAND - SOME GRAVEL	SW	WET - SUB ANG GRAVEL 3/4"Φ MAX SIZE.	0			
S-14	65												
@ 1125	66	24 / 100	.8/1		V DENSE	BRN	SILTY FINE/MED SAND TR GRAVEL AND ROCK FRAGS	SW	WET - COULD BE T.O.R.	0			
				BTM @ 66'						0			
									AUGER REFUSAL @ 66'±				
							SCREEN 55.5-65.5						
							SAND 54-66		4 BAG SAND				
							CHIPS 52-54		1/2 BAG CHIPS				
									6 BAGS TOTAL				

4/27/06

5/2/06

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: USED BAGS SAND
USED " CEMENT

Drilling Area Background (ppm): 0

Converted to Well: Yes X No ____ Well I.D. #: 3MW15I

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSB New London, CT Site 3
BORING No.: 3MW15S
PROJECT NUMBER: CTO 038, G00083
DATE: 4/27/06
DRILLING COMPANY: New England Boring Contractors
GEOLOGIST: Colin Doolan
DRILLING RIG: Mobile B59 Drill
DRILLER: S. Ramsdell

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	MATERIAL DESCRIPTION: Color	MATERIAL DESCRIPTION: Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	PID/FID Reading (ppm): Sampler BZ	PID/FID Reading (ppm): Borehole**	PID/FID Reading (ppm): Driller BZ**
	0												
							See boring log 3MW15I for lithology description						
	5												
	10												
	15												
	20												
	25												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 4 1/4" ID augers

Drilling Area Background (ppm): 0

Converted to Well: Yes X No ____ Well I.D. #: 3MW15S

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME:	NSB New London, CT Site 3	BORING No.:	3MW15S
PROJECT NUMBER:	CTO 038, G00083	DATE:	4/27/06
DRILLING COMPANY:	New England Boring Contractors	GEOLOGIST:	Colin Doolan
DRILLING RIG:	Mobile B59 Drill	DRILLER:	S. Ramsdell

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	U S C S *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ
	25												
							see boring log 3MW15I for Lithology description						
	30												
	35												
	39						total depth: 39'						
							sand: 26' - 39'						
							Screen: 28' - 38'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0

Converted to Well: Yes X No ____ Well I.D. #: 3MW15S

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSB New London, CT Site 3
PROJECT NUMBER: CTO 038, G00083
DRILLING COMPANY: New England Boring Contractors
DRILLING RIG: Mobile B59 Drill
BORING No.: 3MW16D
DATE: 4/19/06 - 4/26/06
GEOLOGIST: Colin Doolan
DRILLER: S. Ramsdell

	Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	Sample	Sampler BZ	Borehole**	Driller BZ**
		0												
	S-1 1410		4 / 6	1 / 2		loose	brown	organic clayey silt,	SM	2 ft. fill	0			
		2	4 / 3					some sand, a few	SM	material	0			
								cobbles (fill material)						
		5								driller noticed grinding augers				
	S-2 1430		34 / 30	1 / 2		dense	light grey	quartz and feldspar fragments, pebbles		at 4'	0			
		7	48 / 48				to tan	and cobbles w/sand		weathered granite	0			
								refusal at 9.5'		used solid augers to 10' to avoid dammaging augers				
4/19/06		10						competent bedrock						
4/21/06								coarse grained		casing				
								granitic gneiss		to 14'				
4/21/06														
4/24/06		15												
	Core 1 1300						pink	coarse grained						
							to grey	granitic gneiss		Solid				
							and black	some bands of		few fractures				
								fine grained						
		20						a few minor fractures						
	Core 2 1345							coarse grained						
								granitic gneiss						
		25						some bands of fine grained						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 4 1/4" ID augers, 2' split spoons
coring below 9.5'

Drilling Area Background (ppm): 0

Converted to Well: Yes X No ____ Well I.D. #: 3MW16D

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSB New London, CT Site 3
PROJECT NUMBER: CTO 038, G00083
DRILLING COMPANY: New England Boring Contractors
DRILLING RIG: Mobile B58 Drill
BORING No.: 3MW16D
DATE: 4/19/06 – 4/26/06
GEOLOGIST: Colin Doolan
DRILLER: S. Ramsdell

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	U S C S *	Remarks	PID/FID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ**
	25												
Core 3						pink to	granitic gneiss		few fractures				
1430						grey and	coarse to fine grained banded						
						black							
	30												
Core 4						pink	coarse grained						
1525							pink granitic gneiss		few fractures				
						grey	fine grained grey						
						and	and black		water pumped from bore hole,				
4/24/06	35					black	granitic gneiss		recovered 1 ft in 2 min.				
4/25/06 Core 5						grey	light and dark		Static water				
0930						and black	banded granitic		level at ~15' bgs				
							gneiss.						
									two minor				
	40								fractures				
Core 6						black	light and dark						
1010						grey and	banded granitic		multiple				
						white	gneiss		fractures				
	45												
Core 7													
1100						pink	coarse to fine		no fractures				
						to	grained granitic						
						grey	gneiss						
	50												

* When rock coring, enter rock brokeness.
** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes X No ____ Well I.D. #: 3MW16D

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSB New London, CT Site 3
PROJECT NUMBER: CTO 038, G00083
DRILLING COMPANY: New England Boring Contractors
DRILLING RIG: Mobile B59 Drill
BORING No.: 3MW16D
DATE: 4/19/06 - 4/26/06
GEOLOGIST: Colin Doolan
DRILLER: S. Ramsdell

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	50												
Core 8						pink	alternating coarse		some				
1340						white and	and fine grained		fractures				
						grey	granitic gneiss						
4/25/06	55												
4/26/06 Core 9						black grey	coarse grained						
0840						and white	granitic gneiss		fractured				
						some pink	dark fine grained						
							banding						
	60												
Core 10						grey and	coarse grained						
0945						black some	granitic gneiss		few fractures				
						pink	trace fine grained						
	65												
Core 11						pink	Coarse to fine						
1040						grey and	grained granitic		some fractures				
						black	gneiss						
	69						total depth: 69						
							sand: 57'-69'						
							screen: 59'-69'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes X No

Well I.D. #: 3MW16D

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSB New London, CT Site 3
PROJECT NUMBER: CTO 038, G00083
DRILLING COMPANY: New England Boring Contractors
DRILLING RIG: Mobile B59 Drill
BORING No.: 3MW16S
DATE: 4/21/06 - 4/26/06
GEOLOGIST: Colin Doolan
DRILLER: S. Ramsdell

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ
	0												
					loose	brown	organic clayey silt	SM	2 ft fill				
							fill material	SM	material				
							a few cobbles						
	5												
					dense	light grey to tan	quartz and feldspar fragments, pebbles and cobbles w/ sand		weathered granite				
							refusal at 8.5' competent bedrock						
	10												
									casing to 13'				
4/21/06 4/26/06	14												
Core 1 1330						pink grey black	granitic gneiss coarse to fine grained						
									large verticle fracture w/ some smaller				
	19												
Core 2 1400						black to grey/white some pink	fine grained granitic gneiss some coarse grained biotite rich		few fractures				
	24												

* When rock coring, enter rock brokeness.
** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 4 1/4" ID augers, 2' split spoons
coring below 8.5' (5 ft)

Drilling Area Background (ppm): 0

Converted to Well: Yes X No ______ Well I.D. #: 3MW16S

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSB New London, CT Site 3
PROJECT NUMBER: CTO 038, G00083
DRILLING COMPANY: New England Boring Contractors
DRILLING RIG: Mobile B59 Drill
BORING No.: 3MW16S
DATE: 4/21/06 - 4/26/06
GEOLOGIST: Colin Doolan
DRILLER: S. Ramsdell

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ
	24												
Core 3				X			v coarse grained		few fractures				
1520				X			granitic gneiss						
				X			with some						
	28						fine grained						
									total depth: 28'				
							sand: 15'-28'						
							screen: 17'-27'						

* When rock coring, enter rock brokeness.
** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes X No ____

Well I.D. #: 3MW16S

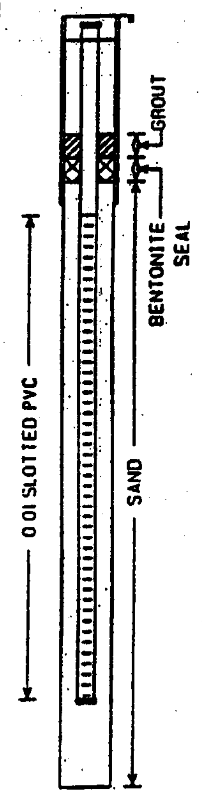
BORING LOG 2D MW 16S

PROJECT: IR STUDY NSB - NLON
PROJECT NO: 1256-10
LOCATION: AREA A DOWNSTREAM
DATE STARTED: 09/18/90
DATA COMPLETED: 09/19/90
DRILLING CONTRACTOR: EMPIRE SOILS INVESTIGATIONS, INC.
DRILLER: JOE RAAB
DRILLING METHOD: HOLLOW STEM AUGER
SAMPLING METHOD: SPLIT SPOON

GROUND ELEVATION: 35.6
PROTECTIVE CASING ELEVATION: 38.08
WELL ELEVATION: 37.85
WATER LEVEL: 34.30 (03/21/91)
DATUM: SUBASE
WEATHER: 60°, CLEAR SKIES, VERY WINDY
INSPECTOR: LYNN METCALF AND ERIK NESS
CHECKED BY: ERIK NESS

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 6"	% RECOVERY	HNU (ppm)	SOIL DESCRIPTION (color, SOIL, admixture, moisture, other notes, ORIGIN)	LEL %	RAD. (cpm)	DEPTH (FT.)
0-2	5 7 10 11	50	0.2	Dark brown, fine SAND and SILT, trace roots, moist, TOP SOIL Brown, medium to coarse SAND and GRAVEL, trace silt, moist	0	40	0.0 0.5
2-4	6 9 10 11	30	0.4		0	50	
4-6	100/5	5	0.2		0	50	
6-8	28 30 13 7	50	0.2	Grey, fine to very fine SAND and SILT, wet	1	50	6.0
8-10	6 20 31 45	60	0.2	Brown, fine to medium SAND and GRAVEL, trace silt, wet	1	40	8.0
10-12	42 100/5	100	0.2		1	50	
12-14	100/5	100	0.2		1	40	13.5
				AUGER REFUSAL AT 13.5 feet			

WELL CONSTRUCTION



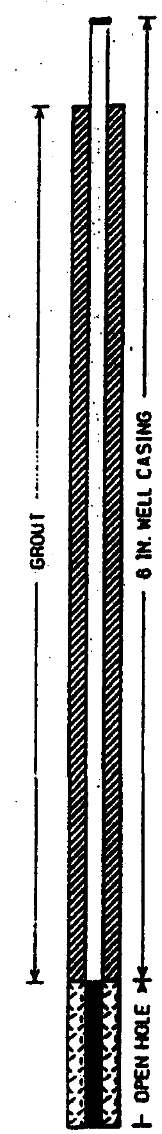
ATLANTIC

BORING LOG 2D MW 16D

PROJECT: IR STUDY NSB - NLON
PROJECT NO: 1256-10
LOCATION: AREA A DOWNSTREAM
DATE STARTED: 09/13/90
DATA COMPLETED: 09/18/90
DRILLING CONTRACTOR: EMPIRE SOILS INVESTIGATIONS, INC.
DRILLER: CRAIG CONNER
DRILLING METHOD: AIR ROTARY
SAMPLING METHOD:

GROUND ELEVATION: 35.9
PROTECTIVE CASING ELEVATION: 37.69
WELL ELEVATION: 37.69
WATER LEVEL: 3.74 (03/21/91)
DATUM: SUBASE
WEATHER: 50-60°, CLEAR SKIES
INSPECTOR: AKHTER HOSSAIN AND LYNN METCALF
CHECKED BY: ERIK NESS

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 6"	% RECOVERY	HNU (ppm)	SOIL DESCRIPTION: color, SOIL, admixture, moisture, other notes, ORIGIN	DEPTH (FT.)	VISUAL CONTAM.: NONE	STAIN	SHEEN	HEAVY	LEL %	RAD. (cpm)	SAMPLE ANALYSIS	LITHOLOGY	DEPTH (FT.)
				FOR SOIL DESCRIPTION SEE BORING LOG 2DMW16S	0									0.0
				BEDROCK										12.5



BORING LOG 2D MW 16D

PROJECT: IR STUDY NSB - NLON
PROJECT NO: 1256-10
LOCATION: AREA A DOWNSTREAM
DATE STARTED: 09/13/90
DATA COMPLETED: 09/18/90
DRILLING CONTRACTOR: EMPIRE SOILS INVESTIGATIONS, INC.
DRILLER: CRAIG CONNER
DRILLING METHOD: AIR ROTARY
SAMPLING METHOD:

GROUND ELEVATION: 35.9
PROTECTIVE CASING ELEVATION: 37.69
WELL ELEVATION: 37.69
WATER LEVEL: 3.74 (03/21/91)
DATUM: SUBASE
WEATHER: 50-60°, CLEAR SKIES
INSPECTOR: AKHTER HOSSAIN AND LYNN METCALF
CHECKED BY: ERIK NESS

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 6"	% RECOVERY	HNU (ppm)	SOIL DESCRIPTION color, SOIL, admixture, moisture, other notes, ORIGIN	DEPTH (FT.)	VISUAL CONTAM. NONE	STAIN	SHEEN	HEAVY	LEL %	RAD. (cpm)	SAMPLE ANALYSIS	LITHOLOGY	DEPTH (FT.)	WELL CONSTRUCTION
					21										OPEN HOLE
					26										
					31										
					36										
					41										

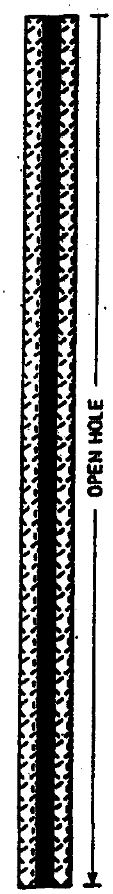
ATLANTIC

BORING LOG 2D MW 16D

PROJECT: IR STUDY NSB - NLON
PROJECT NO: 1256-10
LOCATION: AREA A DOWNSTREAM
DATE STARTED: 09/13/90
DATA COMPLETED: 09/18/90
DRILLING CONTRACTOR: EMPIRE SOILS INVESTIGATIONS, INC.
DRILLER: CRAIG CONNER
DRILLING METHOD: AIR ROTARY
SAMPLING METHOD:

GROUND ELEVATION: 35.9
PROTECTIVE CASING ELEVATION: 37.69
WELL ELEVATION: 37.69
WATER LEVEL: 3.74 (03/21/91)
DATUM: SUBASE
WEATHER: 50-60°, CLEAR SKIES
INSPECTOR: AKHTER HOSSAIN AND LYNN METCALF
CHECKED BY: ERIK NESS

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 6"	% RECOVERY	HNU (ppm)	SOIL DESCRIPTION: color, SOIL, admixture, moisture, other notes, ORIGIN	DEPTH (FT.)	VISUAL CONTAM.: NONE	STAIN	SHEEN	HEAVY	LEL %	RAD (CPM)	SAMPLE ANALYSIS	LITHOLOGY	DEPTH (FT.)	WELL CONSTRUCTION
					42										
					47										
					52										
					57										
				END OF BORING AT 59.91 feet										59.91	
					62										



BORING LOG **HALLIBURTON NUS**

PROJECT: NSB-NLON BORING NO.: 2DMW29S
PROJECT NO.: 9594 DATE: 11-30-93 DRILLER: EAST COAST THOMAS/BRETT SWIATEK
ELEVATION: FIELD GEOLOGIST: T. EVANS
WATER LEVEL DATA :
(Date, Time & Conditions)

SAMPLE NO. & TYPE OR RQD	DEPTH (Ft) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth/Ft)	SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS (HNU)
S-1	0.0	14 / N	2.0/2.0		M. DENSE	BRN	SAND w/ SOME GRAVEL	SW	Max ϕ 0.15" (0 ppm)
@ 1400	2.0	14 / 11					(FILL)		
S-2		7 / 6	0.9/2.0		M. DENSE	BRN	SILTY SAND w/ GRAVEL	SM	MOIST (0 ppm)
	4.0	5 / 5					& SAND (FILL)		Poorly Graded Sand
S-3		4 / 3	1.9/2.0		LOOSE	TAN	SAND	SP	MOIST (0 ppm)
	6.0	3 / 3							Fine, Poorly Graded
S-4		3 / 2	1.3/2.0	6.0'	LOOSE	TAN TO RUST	SAND w/TR ROOTS	SP	WET (0 ppm)
	8.0	3 / 6							Fine, Poorly Graded
S-5		3 / 5	1.0/2.0		M. DENSE	TAN TO RUST	SAND	SP	SATURATED (0 ppm)
	10.0	6 / 7							Fine, Poorly Graded
S-6		3 / 5	1.8/2.0		M. DENSE	TAN TO BRN	SAND	SP	(0 ppm)
	12.0	7 / 9							Fine, Poorly Graded
S-7		9 / 13	2.0/2.0		DENSE	TAN TO BRN		SP	
	14.0	19 / 10							
S-8		8 / 11	1.3/2.0		M. DENSE			SP	
@ 1440	16.0	12 / 13		16.0'					
							HSA to 16'		SCREEN 6'-16'
							SS to 16'		SAND 5'-16'
							8 SAMPLES		PELLETS 3'-5'
							TOTAL DEPTH 16'		

REMARKS CME 75 HSA RIG
4¼" ID AUGER
2" SS TO SAMPLE (140# wt 30" DROP)

BORING 2DMW29S

PAGE 1 OF 1

* See Legend on Back

BORING LOG **HALLIBURTON NUS**

PROJECT: NSB-NLON BORING NO.: 7MW5S

PROJECT NO.: 9594 DATE: 3-8-94 DRILLER: EAST COAST THOMAS/

ELEVATION: FIELD GEOLOGIST: Tim Evans Tim Sabo

WATER LEVEL DATA:

(Date, Time & Conditions)

Sample No. & Type or RQD	Depth (ft) or Run No.	Blows 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/ft)	Soil Density/Consistency or Rock Hardness	Color	Material Classification	Rock Br. or USCS	Remarks
									OVM
S-1 @ 1740	0.0 0.5 1.5	22 13	1.0/1.0		Dense	Tan	Asphalt Silty Sand w/ Tr Gravel & wood	SM	Top 2" M to C Gr
S-2 @ 1348	2.0	100/.3 50 38 10	0.5/0.5		V Dense				Auger Refusal @ 1.75' Move 2' SW
S-3 @ 1414	3.5 4.0	11	1.4/2.0		M. Dense				
S-4 @ 1425	6.0	8 5 13 14	1.7/2.0		M. Dense	Tan	Silty Sand w/ Tr Gravel	SM	F Gr Fe-Stain/mottled
S-5 @ 1433	8.0	7 19 21 17	1.0/2.0		Dense				
S-6 @ 1441	10.0	13 39 48 89	1.7/2.0		V. Dense	D. Brn	Silty Sand & Gravel Cobble	SM/GM	Moist
S-7 @ 1400	11.0	22 100	0.6/1.0		V. Dense	D. Brn			
1/8 3/9 .925 S-8 @ 1506	12.0	100/.0	0.1/0.0						Very Micaceous
								VBr	Auger Refusal @ 12'
								Br	0945 Rock blocked in core barrel
1.5/2.5	①	60%	2.5/5.0		Hard	Gray	Gneiss		Hi ∅ Frac 12.25' 14.0'
									Poor Recovery Highly Fractured
.20	17.0								Cave-in to 14.0'
							-Total Depth 17'-		3/14 Spin Casing to 14.7'
									H_2O level 9.35' gs @ 1700
									3/15 @ 0822 12.1' gs Rollerbit to 17'
									Spin Casing to 16.5'
							Screen 7'-17' →		10'-2" PVC (Schedule 40 0.010 Slot)
							Sand 6'-17' →		1-100# Bag Ottawa Sand
							Pellets 2.5'-6' →		1-58# Bag

REMARKS Diedrich D-50 HSA Rig (Bombadier Mounted)
3" x 24" SST (30" Drop, 140# wt, Cat Head)
4¼" ID, 8" OD Auger
4" Spin Casing
3⅞" Rollerbit

* See Legend on Back

BORING 7MW5S

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000010

BORING LOG HALLIBURTON NUS

PROJECT: NSB-NLON BORING NO.: 7MW5D
PROJECT NO.: 9594 DATE: 3-15-95 DRILLER: EAST COAST THOMAS
ELEVATION: FIELD GEOLOGIST: James R. Ferguson
WATER LEVEL DATA:
(Date, Time & Conditions) 3-15-95 OVERCAST RAIN 45° 3-16-93 CLEAR 45°

SAMPLE NO. & TYPE OR RQD	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY / SAMPLE LENGTH	LITHOLOGY CHANGE (Depth/Ft.)	MATERIAL DESCRIPTION* SOIL DENSITY/CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
							SEE BORING LOG 7MW5S		
							FOR LITHOLOGIC DETAILS		SET 6¼" Ø STEEL CASING
							FROM G.S. TO 15.0'		from G.S. To 16.0'
	14-15								
						PINK-GRAY-BLACK	GRANITE BIOTITE QUARTZ and		WELL BEGAN producing
							K SPAR		a significant quantity
									of water between 18' and
									25'
	19-20					BLK-GRAY BLACK	GRANITE BIOTITE QUARTZ and		
							K SPAR		
	24-25					GRAY-BLACK	GNEISS		
	29-30					GRAY-BLACK	GNEISS		
	34-35					GRAY-BLACK	GNEISS		

REMARKS Driller: Dick Spaulding Rig: Mustang Plymouth

BORING 7MW5D

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* See Legend on Back

000012

BORING LOG **HALLIBURTON NUS**

PROJECT: NSB-NLON BORING NO.: 7MW5D
PROJECT NO.: 9594 DATE: 3-15-94 DRILLER: EAST COAST THOMAS
ELEVATION: FIELD GEOLOGIST: J.P. Ferguson
WATER LEVEL DATA:
(Date, Time & Conditions) 3-15-95 Overcast Rain 45° 3-16-95 Clear 45°

SAMPLE NO. & TYPE OR RQD	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth/Ft.)	SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	ROCK BR. OR USCS	REMARKS
									No significant water
	39-41					Gray-Black	GNEISS		bearing zones were
									noticed during drilling
	41-42								17:00
							Bottom of Boring: 42.0'		
							Installed 2" PVC Monitoring		3-16-95
							well Screen 32'-42',		
							Sandpack 28.5-42.0' Bentonite		
							pellet seal 14.5'-28.5 Cement		
							14.5'-2.5'		

REMARKS Well Construction Diagram on P. 123 of Notebook 2230

BORING 7MW5D

PAGE 2 OF 2

* See Legend on Back

000013

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSB New London, CT Site 7
PROJECT NUMBER: CTO 038, G00083
DRILLING COMPANY: New England Boring Contractors
DRILLING RIG: Mobile B59 Drill

BORING No.: 7MW12I
DATE: 5/17/06
GEOLOGIST: Colin Doolan
DRILLER: S. Ramsdell

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Sample	PID/FID Sampler BZ	PID/FID Borehole**	PID/FID Driller BZ**
	0												
					loose	dk brown to	organic top soil	OL	fill material	0		0	
					↓	brown	sandy silt	SM	v. wet	0			
				3'					water table at 3'				
	5												
S-1 0837		1 / 2	2 / 2		loose	dk orange brown	0.5 ft coarse sand; 1.0 ft silt trace clay	SM	saturated (fill)	0			
		3 / 16			↓ med dense	grey brown	trace roots; 0.5 ft silt		v wet; moist	0			
	10												
S-2 0850		7 / 7	1.5 / 2		med dense	orange green brown	silt	SM	wet	0			
		9 / 11			dense	blue grey			↓ moist	0			
	15												
S-3 0915		7 / 12	2 / 2		med dense	blue grey	fine sand w silt	SM	saturated	0		0	0
		24 / 31			to dense	lt brown	sandy silt		to wet	0			
	20												
S-4 0920		12 / 14	1.3 / 2		dense	brown	silt	SM	saturated	0	0		
		18 / 21				blue grey	silt w/ trace clay			0			
	25												

* When rock coring, enter rock brokeness.
** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 4 1/4 ID augers, 2' split spoons

Drilling Area Background (ppm): 0

Converted to Well: Yes X No ____ Well I.D. #: 7MW12I

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSB New London, CT Site 7
BORING No.: 7MW12I
PROJECT NUMBER: CTO 038, G00083
DATE: 5/17/06
DRILLING COMPANY: New England Boring Contractors
GEOLOGIST: Colin Doolan
DRILLING RIG: Mobile B59 Drill
DRILLER: S. Ramsdell

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ
	25												
S-5 0950		7 / 12	1.8 / 2		stiff	blue grey	1 ft. silt w/ clay	SC	damp	0			
		14 / 20			dense		1 ft silt	SM	↓	0			
	30												
S-6 1010		100	0.5 / 2		dense	brn to grey	silt	SM	bedrock refusal at 30.5'	0			
							total depth: 30'						
							sand: 18' - 30.5'						
							screen: 20' - 30'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 4 1/4" ID augers, 2' split spoons

Drilling Area Background (ppm): 0

Converted to Well: Yes X No ____ Well I.D. #: 7MW12I

BORING LOG

PROJECT NAME: NSB-NLON - Data Gap
PROJECT NUMBER: CTO 841 # 4286
DRILLING COMPANY: New England Boring
DRILLING RIG: DPT
BORING NUMBER: 15TW3
DATE: 10.22.02
GEOLOGIST: Keith Simpson
DRILLER: JEFF LEAVITT

	Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	Sample	Sampler BZ	Borehole**	Driller BZ
1100		1					BRN	ASPHALT/ GRAVEL		DRY	0	0	0	0
		2				MED STIFF		C. SAND & GRAVEL	SW	MOIST				
		3												
		4		3/4										
		5					GY.	F. SAND & SILT- ROOT FRAGS		GRAY TO OLIVE COLOR				
		6							SM	WET				
		7					BRN	COARSE SAND						
		8		4/4				FINE SAND TR. SILT		BRN/GRAY				
		9				SOFT								
		10												
		11												
		12						TR. RUST COLOR						
		13						MOTTLING THRU-OUT						
		14												
1140		15												
		16			TD			HOLE CAVED @						
		17						3' - OFFSET						
		18						2' NE						
		19												
		20												
								TOTAL 30' OF DPT						
								15' TW		CONSTRUCTION				
							TD = 15							

* When rock coring, enter rock brokeness.
** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: CUT ASPHALT WITH DPT DRILL BIT

Drilling Area Background (ppm): 0

Converted to Well: Yes ______ No ______ Well I.D. #: ______

BORING LOG — **HALLIBURTON NUS**

PROJECT: NSB-NLON BORING NO.: 2WCMW25
PROJECT NO.: 9594 DATE: 1-20-94 DRILLER: EAST COAST THOMAS
ELEVATION: FIELD GEOLOGIST: J.R. FERGUSON
WATER LEVEL DATA:
(Date, Time & Conditions) 1-20-94 - 5°

SAMPLE NO. & TYPE OR RQD	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth/Ft.)	SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	USCS	REMARKS
	0-1						Asphalt and gravel Sub-base		
S-1	2-4	12 / 8	1.0		M. Dense	Brown	Silty, Fine to Coarse Sand	SW	HNU-0 15:27
		4 / 4	2.0			Brown	Some Granitic Rock Fragments	SW	Moist
S-2	4-6	5 / 3	.6		Loose	Brown		SW	HNU-0 15:34
		3 / 2	2.0		▽	Brown		SW	Wet (Drove 2 Spoons)
S-3	6-8	1 / 1	.6		V. Loose	Brown		SW	HNU-0 15:52
		1 / 2	2.0			Brown		SW	Wet
S-4	8-10	1 / 2	.5		Loose	Brown		SW	HNU-0 16:06
		3 / 4	2.0			Brown		SW	Wet
S-5	10-12	3 / 9	.5		M. Dense	Brown		SW	HNU-0 16:20
		20 / 10	2.0			Brown		SW	Wet
S-6	12-14	4 / 3	1.0		Loose	Brown		SW	HNU-0 16:34
		4 / 7	2.0			Brown		SW	Wet
S-7	14-16	4 / 5	1.6		Loose	Brown-Black		SM	HNU-0 16:42
		1 / 1	2.0		M. Stiff	Black	Organic Clayey Silt, Tr Org	ML	Wet/Moist
S-8	16-18	W / O	2.0		V. Soft	Green-Gray	material, wood etc.		HNU-0 16:56
		R / 1	2.0			Green-Gray			Moist
							Bottom of Boring = 18.0		

REMARKS Rig CME 75 - Floyd Cross

BORING 2WCMW25

PAGE 1 OF 1

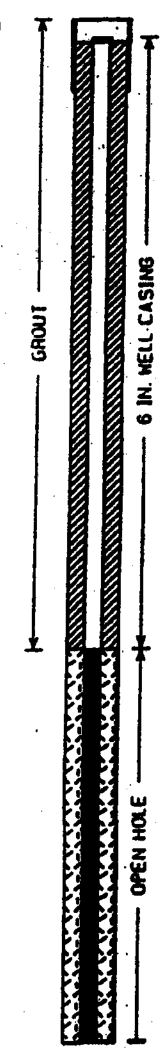
* See Legend on Back

BORING LOG 2W MW 4D

PROJECT: IR STUDY NSB - NLON
PROJECT NO: 1256-10
LOCATION: AREA A WETLAND
DATE STARTED: 09/19/90
DATA COMPLETED: 09/27/90
DRILLING CONTRACTOR: EMPIRE SOILS INVESTIGATIONS, INC.
DRILLER: CRAIG CONNER
DRILLING METHOD: AIR ROTARY
SAMPLING METHOD:

GROUND ELEVATION: 93.07
PROTECTIVE CASING ELEVATION: 92.69
WELL ELEVATION: 92.69
WATER LEVEL: 7.43 (03/21/91)
DATUM: SUBASE
WEATHER: 65° , CLEAR, SUNNY
INSPECTOR: AKHTER HOSSAIN AND LYNN METCALF
CHECKED BY: ERIK NESS

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 6"	% RECOVERY	HNU (ppm)	SOIL DESCRIPTION color, SOIL, admixture, moisture, other notes, ORIGIN	DEPTH (FT.)	VISUAL CONTAM. NONE	STAIN	SHEEN	HEAVY	LEL %	RAD (cpm)	SAMPLE ANALYSIS	LITHOLOGY	DEPTH (FT.)	WELL CONSTRUCTION
				FOR OVERBURDEN SOIL DESCRIPTION SEE BORING LOG 2WMW4S	0									0.0	
					5										
				BEDROCK	10									9.0	
					15										
					20										

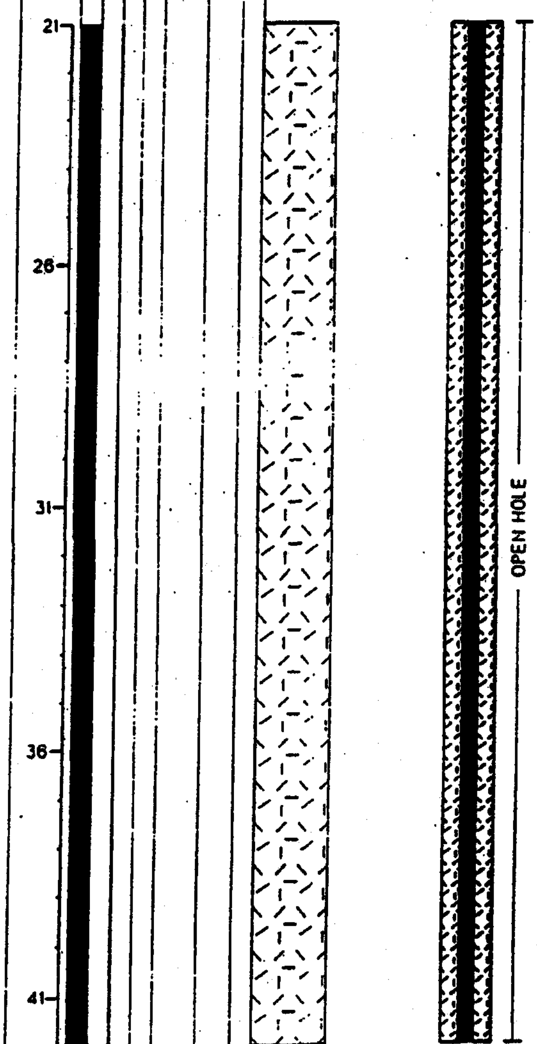


BORING LOG 2W MW 4D

PROJECT: IR STUDY NSB - NLON
PROJECT NO: 1256-10
LOCATION: AREA A WETLAND
DATE STARTED: 09/19/90
DATA COMPLETED: 09/27/90
DRILLING CONTRACTOR: EMPIRE SOILS INVESTIGATIONS, INC.
DRILLER: CRAIG CONNER
DRILLING METHOD: AIR ROTARY
SAMPLING METHOD:

GROUND ELEVATION: 93.07
PROTECTIVE CASING ELEVATION: 92.69
WELL ELEVATION: 92.69
WATER LEVEL: 7.43 (03/21/91)
DATUM: SUBASE
WEATHER: 65°, CLEAR, SUNNY
INSPECTOR: AKHTER HOSSAIN AND LYNN METCALF
CHECKED BY: ERIK NESS

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 6"	% RECOVERY	HNU (ppm)	SOIL DESCRIPTION: color, SOIL, admixture, moisture, other notes, ORIGIN	DEPTH (FT.)	VISUAL CONTAM.: NONE	STAIN	SHEEN	HEAVY	LEL %	RAD (ppm)	SAMPLE ANALYSIS	LITHOLOGY	DEPTH (FT.)	WELL CONSTRUCTION



BORING LOG 2W MW 4D

PROJECT: IR STUDY NSB - NLON
PROJECT NO: 1256-10
LOCATION: AREA A WETLAND
DATE STARTED: 09/19/90
DATA COMPLETED: 09/27/90
DRILLING CONTRACTOR: EMPIRE SOILS INVESTIGATIONS, INC.
DRILLER: CRAIG CONNER
DRILLING METHOD: AIR ROTARY
SAMPLING METHOD:

GROUND ELEVATION: 93.07
PROTECTIVE CASING ELEVATION: 92.69
WELL ELEVATION: 92.69
WATER LEVEL: 7.43 (03/21/91)
DATUM: SUBASE
WEATHER: 65° . CLEAR, SUNNY
INSPECTOR: AKHTER HOSSAIN AND LYNN METCALF
CHECKED BY: ERIK NESS

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 6"	% RECOVERY	HNU (ppm)	SOIL DESCRIPTION: color, SOIL, admixture, moisture, other notes, ORIGIN	DEPTH (FT.)	VISUAL CONTAM.: NONE	STAIN	SHEEN	HEAVY	LEL %	RAD. (cpm)	SAMPLE ANALYSIS	LITHOLOGY	DEPTH (FT.)	WELL CONSTRUCTION
					42										
					47										
					52										OPEN HOLE
					57										
					62										

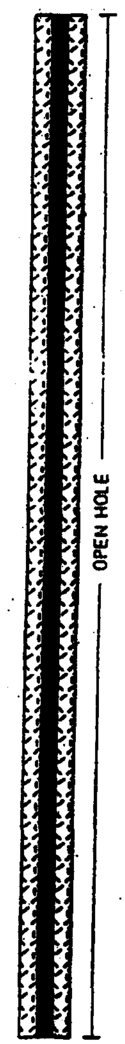
ATLANTIC

BORING LOG 2W MW 4D

PROJECT: IR STUDY NSB - NLON
PROJECT NO: 1256-10
LOCATION: AREA A WETLAND
DATE STARTED: 09/19/90
DATA COMPLETED: 09/27/90
DRILLING CONTRACTOR: EMPIRE SOILS INVESTIGATIONS, INC.
DRILLER: CRAIG CONNER
DRILLING METHOD: AIR ROTARY
SAMPLING METHOD:

GROUND ELEVATION: 93.07
PROTECTIVE CASING ELEVATION: 92.69
WELL ELEVATION: 92.69
WATER LEVEL: 7.43 (03/21/91)
DATUM: SUBASE
WEATHER: 65°, CLEAR, SUNNY
INSPECTOR: AKHTER HOSSAIN AND LYNN METCALF
CHECKED BY: ERIK NESS

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 6"	% RECOVERY	HNU (ppm)	SOIL DESCRIPTION: color, SOIL, admixture, moisture, other notes, ORIGIN	DEPTH (FT.)	VISUAL CONTAM.: NONE	STAIN	SHEEN	HEAVY	LEL %	RAD (CPM)	SAMPLE ANALYSIS	LITHOLOGY	DEPTH (FT.)	WELL CONSTRUCTION
					63										
					68										
					73										
					78										
					83										



BORING LOG 2W MW 4D

PROJECT: IR STUDY NSB - NLON
PROJECT NO: 1256-10
LOCATION: AREA A WETLAND
DATE STARTED: 09/19/90
DATA COMPLETED: 09/27/90
DRILLING CONTRACTOR: EMPIRE SOILS INVESTIGATIONS, INC.
DRILLER: CRAIG CONNER
DRILLING METHOD: AIR ROTARY
SAMPLING METHOD:

GROUND ELEVATION: 93.07
PROTECTIVE CASING ELEVATION: 92.69
WELL ELEVATION: 92.69
WATER LEVEL: 7.43 (03/21/91)
DATUM: SUBASE
WEATHER: 65°, CLEAR, SUNNY
INSPECTOR: AKHTER HOSSAIN AND LYNN METCALF
CHECKED BY: ERIK NESS

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 6"	% RECOVERY	HNU (ppm)	SOIL DESCRIPTION: color, SOIL, admixture, moisture, other notes, ORIGIN	DEPTH (FT.)	VISUAL CONTAM.: NONE	STAIN	SHEEN	HEAVY	LEL %	RAD (cpm)	SAMPLE ANALYSIS	LITHOLOGY	DEPTH (FT.)	WELL CONSTRUCTION
					84										OPEN HOLE
					89										
					94										
					99										
					104										

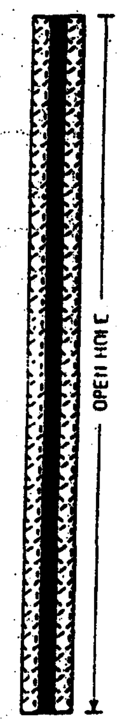
ATLANTIC

BORING LOG 2W MW 4D

PROJECT: IR STUDY NSB - NLON
PROJECT NO: 1256-10
LOCATION: AREA A WETLAND
DATE STARTED: 09/19/90
DATA COMPLETED: 09/27/90
DRILLING CONTRACTOR: EMPIRE SOILS INVESTIGATIONS, INC
DRILLER: CRAIG CONNER
DRILLING METHOD: AIR ROTARY
SAMPLING METHOD:

GROUND ELEVATION: 93.07
PROTECTIVE CASING ELEVATION: 92.69
WELL ELEVATION: 92.69
WATER LEVEL: 7.33 (03/21/91)
DATUM: SUBASE
WEATHER: 65°, CLEAR, SUNNY
INSPECTOR: AKHTER HOSSAIN AND LYNN METCALF
CHECKED BY: ERIK NESS

SPLIT SPOON SAMPLE DEPTH (ft)	BLOWS PER 6"	% RECOVERY	HNU (ppm)	SOIL DESCRIPTION color, SOIL, admixture, moisture, other notes, ORIGIN	DEPTH (FT.)	VISUAL CONTAM.: NONE	STAIN	SHEEN	HEAVY	LEL %	RAD. (CPM)	SAMPLE ANALYSIS	LITHOLOGY	DEPTH (FT.)	WELL CONSTRUCTION
					105										
					110										
					115										
														119.4	
				END OF BORING AT 119.38 feet	120										
					125										



BORING LOG

PROJECT NAME: NSB-NLON
PROJECT NUMBER: CTO 241 4626
DRILLING COMPANY: SOILTEST, INC
WATER LEVEL DATA:

BORING NUMBER: HNUS 23
DATE: 10-4-95
GEOLOGIST: STAN CONTI

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows/6" or RQD (%)	Sample Recovery/Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID or FID Reading (ppm)
S-1	0.0	5/11	1.8/2.0		M DENSE	BRN	SILTY SAND - TR ROOTS/	SM	MOIST	0/.2
1350	2.0	13/13			↓	↓	ROCK FRAG.			
S-2		9/10	1.7/2.0		M DENSE	TAN BRN	SILTY SAND - SOME ROCK	SM	MOIST	0/.2
1352	4.0	8/13			↓		FRAG			
S-3		8/6	1.5/2.0		M DENSE		FINE TO MED SAND	SM	DAMP → MOIST	0/.4
1405	6.0	7/5			↓			SP		
S-4		1/2	1.3/2.0	7	M DENSE	TAN GRAY	SILTY F. MED SAND	SM	MOIST	0/.2
1407	8.0	3/8						SP		
S-5	•	9/8	1.5/2.0	9.0		GRAY			MOIST → WET	0/.4
1415	10.0	10/11		HIT H_2O ≈9			SILTY F SAND	SM	≈ 9' WET SENT	
S-6		8/10	1.6/2.0		M DENSE	BRN TO			SWSO23-08	
1418	12.0	10/9				GRAY	SILTY VF SAND	SM	WET	0/
									ALMOST SANDY SILT	
	15.0									
S-7		4/5	1.8/2.0		M DENSE	TAN BRN	SILTY F SAND - SANDY	SM	WET	0/.2
1430	17.0	8/8		17.0			SILT	ML	? MOTTLED w/ LAYERING	
							HSA TO 17			
							SPOONS 7			
							SCREEN 7-17			
							SAND 5-17			
							PELLETS 3-5			
							FLUSH MT (GROUT TO SURF)			

*When rock coring enter rock brokeness.

CONVERTED TO WELL: ✓ Yes ___ No:

WELL I.D.#: HNUS-23

REMARKS:
SET UP 1340 HRS. • TO LAB (SWLOK)

Signature(s):

TABLE 4-4

GROUNDWATER ELEVATIONS - ROUNDS 9 THROUGH 11
YEAR 3 GROUNDWATER MONITORING REPORT FOR AREA A LANDFILL
NSB-NLON, GROTON, CONNECTICUT

WELL ID	Reference Elevation(2) (feet)	Round 9 December-01		Round 10 March-02		Round 11 September-02	
		Depth to Water	Groundwater Elevation(2) (feet)	Depth to Water	Groundwater Elevation(2) (feet)	Depth to Water	Groundwater Elevation(2) (feet)
4MW1S	129.55	9.9 *	119.65	6.29 *	123.26	8.15	121.40
2LMW20S	86.83	18.02	68.81	15.81	71.02	16.53	70.30
2WMW21S	76.31	4.98	71.33	4.33	71.98	4.77	71.54
3MW37S	47.26	3.79 *	43.47	3.61 *	43.65	3.65	43.61
3MW12D(1)	47.22	--	--	--	--	4.44(3)	42.78
2WMW38DS	74.06	7.61	66.45	5.81	68.25	7.93	66.13
2WMW39DS	73.53	3.4 *	70.13	2.40 *	71.13	3.31	70.22
2WMW40DS	73.21	3.81	69.40	3.15	70.06	3.79	69.42
2WMW41DS	73.39	3.24	70.15	2.42	70.97	2.89	70.50
2WMW42DS	73.65	2.5	71.15	2.05	71.60	2.64	71.01
2WMW43DS	74.36	3.28	71.08	2.44	71.92	2.90	71.46
2WMW44DS	73.72	2.29	71.43	1.62	72.10	2.00	71.72
2WMW45DS	74.24	2.95	71.29	2.12	72.12	2.60	71.64
2WMW46DS	73.53	2.28 *	71.25	1.55 *	71.98	1.97	71.56
2WMW47DS	73.39	2.37	71.02	1.38	72.01	1.75	71.64
2LMW29A(1)	91.37	--		--		8.91	82.46
2LMW29F(1)	91.50	--		--		10.56	80.94
2LMW7S(1)	84.87	--		--		11.85	73.02
2LMW7D(1)	85.74	--		--		6.65	79.09
2LMW32F(1)	84.52	--		--		13.18	71.34
2LMW32DS(1)	84.17	--		--		12.57	71.60
2LMW32B(1)	84.81	--		--		12.21	72.60

1 No water levels were taken in these wells during Rounds 9 and 10.
2 Elevations based on Base 1982 Vertical Datum.
3 Water level measured in December 2002.

TABLE 3-1

MONITORING WELL CONSTRUCTION AND ROUND 4 WATER LEVEL INFORMATION
YEAR 1 ANNUAL GROUNDWATER MONITORING REPORT FOR SITES 3 AND 7
NSB-NLON, GROTON, CONNECTICUT

Monitoring Well	Northing (1)	Easting (1)	Ground Surface Elev (ft) (2)	Top of Casing Elev (ft) (2)	Top of Riser Elev (ft) (2)	Screened Aquifer	Screen Top Depth (ft)	Screen Bottom Depth (ft)	Screen Top Elev (ft) (2)	Screen Bottom Elev (ft) (2)	Depth to Water (ft)(3)	Groundwater Elevation (ft)(3)
Site 3												
2DMW16S	708522.1	1181411.1	33.21	35.69	35.46	Overburden (Alluvium)	1.69	11.69	31.52	21.52	3.87	31.59
2DMW16D	708531.9	1181404.8	33.51	35.30	NA	Bedrock	18.00	59.91	15.51	-26.40	3.72 *	31.58
2DMW25S	708649.4	1180952.5	31.09	33.02	32.59	Overburden (Fill)	5.50	10.50	25.59	20.59	6.80	25.79
2DMW28D	708835.6	1180594.4	33.22	33.22	33.01	Bedrock	26.00	136.00	7.22	-102.78	16.11	16.90
2DMW29S	709579.0	1181082.1	32.59	34.47	34.29	Overburden (Alluvium)	6.00	16.00	26.59	16.59	8.57 *	25.72
3MW15S	709329.6	1180638.3	33.20	33.24	32.86	Overburden (Alluvium)	28.00	38.00	5.20	-4.80	29.38 *	3.48
3MW15I	709351.2	1180640.8	33.50	33.53	33.10	Overburden (Alluvium)	55.50	65.50	-22.00	-32.00	30.85 *	2.25
3MW16S	709908.8	1180730.0	36.10	36.10	35.78	Bedrock	17.00	27.00	19.10	9.10	14.36 *	21.42
3MW16D	709899.8	1180723.2	36.20	36.19	35.80	Bedrock	59.00	69.00	-22.80	-32.80	22.12 *	13.68
Site 7												
7MW1D	709291.1	1182145.8	52.28	NA	51.69	Bedrock	14.20	25.20	38.08	27.08	8.98	42.71
7MW3S	709033.9	1181704.2	43.59	43.59	43.32	Overburden (Fill/Alluvium)	6.90	16.90	36.69	26.69	5.60	37.72
7MW3I	709021.9	1181707.0	43.40	45.38	45.21	Overburden (Alluvium)	22.50	32.50	20.90	10.90	7.35	37.86
7MW5D	709280.3	1181887.3	54.43	54.43	54.18	Bedrock	32.00	42.00	22.43	12.43	12.40 *	41.78
7MW9S	709177.8	1181377.0	35.80	35.77	35.40	Overburden (Alluvium)	4.00	14.00	31.81	21.81	3.86	31.54
7MW12S	709075.9	1181805.7	44.10	44.13	43.62	Overburden (Fill/Alluvium)	3.50	13.50	40.60	30.60	3.26	40.36
7MW12I	709070.3	1181808.8	44.20	44.22	43.90	Overburden (Alluvium)	20.00	30.00	24.20	14.20	4.97 *	38.93
7MW13S	708891.7	1181882.7	48.60	50.79	50.58	Overburden (Fill/Alluvium)	6.50	16.50	42.10	32.10	8.91	41.67

1 North American Datum (NAD) 83, Connecticut State Plane Coordinate System
2 North American Vertical Datum (NAVD) 88 (NAVD 88 = 1982 Base Vertical Datum - 2.39 feet(3)). Vertical datum conversion factor of 2.39 feet was provided by NSB-NLON Public Works Department.
3 Water levels were measured on March 17th and 18th, 2007.
NA - Not available
Elev - Elevation
ft - Feet

TABLE 2-2

WATER LEVEL MEASUREMENTS AND ELEVATIONS
OCTOBER 2002 DGI
BASEWIDE GROUNDWATER OU RI UPDATE/FS
NSB-NLON, GROTON, CONNECTICUT

Well Name	Depth to Top of Monitored Interval (feet bgs)	Depth to Bottom of Monitored Interval (feet bgs)	Reference Point Elevation(1) (feet)	Reference Point Elevation(2) (feet)	Well Diameter (inches)	Aquifer Monitored	October 2002 Depth to Water (feet)	October 2002 Water Elevation(2) (feet)
SITES 3/14								
2DMW10D	10.00	26.09	54.52	52.13	6	BEDROCK	10.13	42.00
2DMW11D	19.50	25.50	53.20	50.81	6	BEDROCK	NM(3)	NA
2DMW11S	2.50	12.50	46.85	44.46	2	OVERBURDEN (ALLUVIUM)	2.09	42.37
2DMW15D	10.00	19.51	44.09	41.70	6	BEDROCK	7.32	34.38
2DMW16D	18.00	59.91	37.69	35.30	6	BEDROCK	5.28	30.02
2DMW16S	1.69	11.69	37.85	35.46	2	OVERBURDEN (ALLUVIUM)	5.85	29.61
2DMW23D	7.50	65.00	83.38	80.99	6	BEDROCK	30.41	50.58
2DMW24D	25.00	45.00	36.07	33.68	6	BEDROCK	4.65	29.03
2DMW24S	4.00	14.00	36.29	33.90	2	OVERBURDEN (ALLUVIUM)	NM(4)	NA
2DMW25D	18.00	40.00	35.48	33.09	6	BEDROCK	8.48	24.61
2DMW25S	5.50	10.50	34.98	32.59	2	OVERBURDEN (FILL)	8.12	24.47
2DMW26D	30.00	40.00	29.19	26.80	2	OVERBURDEN (ALLUVIUM))	10.51	16.29
2DMW26S	8.00	18.00	28.71	26.32	2	OVERBURDEN (ALLUVIUM)	6.63	19.69
2DMW27D	20.00	205.00	27.95	25.56	6	BEDROCK	12.96	12.60
2DMW28D	26.00	136.00	35.40	33.01	6	BEDROCK	16.95	16.06
2DMW28S	17.00	22.00	35.26	32.87	2	OVERBURDEN (ALLUVIUM)	18.23	14.64
2DMW29S	6.00	16.00	36.68	34.29	2	OVERBURDEN (ALLUVIUM)	9.11	25.18
2DMW30S	4.00	9.00	33.11	30.72	2	OVERBURDEN (ALLUVIUM)	7.35	23.37
3MW12D	20.00	25.00	47.22	44.83	2	BEDROCK	4.44	40.39(5)
3MW14S	28.00	38.00	36.81	34.42	2	OVERBURDEN (ALLUVIUM)	32.16	2.26
14MW1S	4.00	14.00	51.54	49.05	2	OVERBURDEN (ALLUVIUM)	5.01	44.04
3TW27	1.00	6.00	38.20	35.81	1	OVERBURDEN (ALLUVIUM)	5.86	29.95
3TW28	1.70	6.70	39.56	37.17	1	OVERBURDEN (ALLUVIUM)	7.12	30.05
3TW29	3.00	7.50	38.96	36.57	1	OVERBURDEN (ALLUVIUM)	8.78	27.79
3TW30	6.00	16.00	37.81	35.42	1	OVERBURDEN (ALLUVIUM)	8.13	27.29
SITE 7								
7MW10S	4.00	14.00	43.42	41.03	2	OVERBURDEN (ALLUVIUM)	12.25	28.78
7MW3D	23.80	33.80	46.67	44.28	2	OVERBURDEN (ALLUVIUM)	8.90	35.38
SITE 20								
2WCMW1S	8.00	18.00	83.92	81.53	2	OVERBURDEN (FILL/DREDGE)	12.10	69.43
2WCMW2S	4.00	14.00	86.16	83.77	2	OVERBURDEN (FILL)	4.57*	79.20
2WCMW3S	5.75	15.75	85.95	83.56	2	OVERBURDEN (FILL/DREDGE)	10.03	73.53
2WMW4D	13.00	119.40	92.69	90.30	6	BEDROCK	6.14*	84.16
SITE 15								
15MW1D	36.00	46.00	28.05	25.66	2	OVERBURDEN (ALLUVIUM)	10.24	15.42
15MW1S	5.00	15.00	28.08	25.69	2	OVERBURDEN (ALLUVIUM)	7.02	18.67
15MW2S	5.00	15.00	28.90	26.51	2	OVERBURDEN (ALLUVIUM)	7.82	18.69
15MW3S	5.00	15.00	26.26	23.87	2	OVERBURDEN (ALLUVIUM)	5.81	18.06
15TW01	5.00	15.00	29.62	27.23	1	OVERBURDEN (ALLUVIUM)	8.45	18.78
15TW02	5.00	15.00	29.09	26.70	1	OVERBURDEN (ALLUVIUM)	7.98	18.72
15TW03	5.00	15.00	27.52	25.13	1	OVERBURDEN (ALLUVIUM)	6.49*	18.64

Notes:
1 Elevation based on Base 1982 Vertical Datum.
2 Elevation based on NAVD 1988.
3 A water level measurement could not be taken at monitoring well 2DMW24S because it could not be located. It was assumed to have been destroyed.
4 A water level measurement could not be taken at monitoring well 2DMW11D because it was destroyed.
5 Measured on 12/04/02.

bgs = Below ground surface.
NA = Not applicable.
NM = No Measurement.

TABLE 2-2

WATER TABLE ELEVATION SUMMARY - JUNE 2000
BASEWIDE GROUNDWATER OU RI
NSB-NLON, GROTON, CONNECTICUT

Well Name	Depth to Top of Screen (Feet)	Depth to Bottom of Screen (Feet)	Top of Casing Elevation 1982 Datum	Top of Casing Elevation 1988 Datum	Well Diameter	Aquifer Monitored	Depth to Water (feet) June 2000	Water Elevation (ft-msl)* June 2000
7MW4S	4.00	14.00	46.84	44.45	2	BEDROCK	2.08	42.37
7MW5D	32.00	42.00	56.57	54.18	2	BEDROCK	11.84	42.34
7MW5S	7.00	17.00	56.62	54.23	2	OVERBURDEN (ALLUVIUM)/ BEDROCK	11.9	42.33
7MW6S	4.00	14.00	46.65	44.26	2	OVERBURDEN (ALLUVIUM)	3.97	40.29
7MW7S	5.50	15.50	46.57	44.18	2	BEDROCK	1.87	42.31
7MW8S	3.00	13.00	42.10	39.71	2	OVERBURDEN (ALLUVIUM)	3.81	35.90
7MW9S	4.00	14.00	37.91	35.52	2	OVERBURDEN (ALLUVIUM)	4.48	31.04
B325-MW1	3.00	13.00	47.23	44.84	2	OVERBURDEN/BEDROCK	2.53	42.31
B325-MW3	2.50	12.50	46.05	43.66	2	OVERBURDEN	1.24	42.42
B325-MW4	4.00	14.00	46.88	44.49	2	OVERBURDEN	3.42	41.07
SOUTHERN REGION WELLS								
8MW1	6.40	16.40	10.15	7.76	2	OVERBURDEN (FILL)	8.37	-0.61
8MW2D	54.00	64.00	9.77	7.38	2	OVERBURDEN (ALLUVIUM)	7.18	0.20
8MW2S	5.90	15.90	9.43	7.04	2	OVERBURDEN (FILL)	6.52	0.52
8MW3	5.80	15.80	8.96	6.57	2	OVERBURDEN (FILL)	6.09	0.48
8MW4	5.40	14.40	9.34	6.95	2	OVERBURDEN (FILL)	6.14	0.81
8MW5S	6.00	16.00	10.94	8.55	2	OVERBURDEN (FILL)	9.03	-0.48
8MW6D	60.00	70.00	9.62	7.23	2	OVERBURDEN (ALLUVIUM)	7.15	0.08
8MW6S	4.00	14.00	9.66	7.27	2	OVERBURDEN (FILL)	6.43	0.84
8MW8D	48.00	78.00	19.53	17.14	2	BEDROCK	16.58	0.56
8MW8S	7.00	17.00	19.68	17.29	2	OVERBURDEN (ALLUVIUM)/ BEDROCK	14.67	2.62
15MW1D	36.00	46.00	28.05	25.66	2	OVERBURDEN (ALLUVIUM)	9.22	16.44
15MW1S	5.00	15.00	28.08	25.69	2	OVERBURDEN (ALLUVIUM)	3.87	21.82
15MW2S	5.00	15.00	28.90	26.51	2	OVERBURDEN (ALLUVIUM)	4.61	21.90
15MW3S	5.00	15.00	26.26	23.87	2	OVERBURDEN (ALLUVIUM)	4.38	19.49
23MW01D	50.00	56.50	36.83	34.44	2	BEDROCK	3.85	30.59
23MW02D	18.60	28.50	23.19	20.80	8	BEDROCK	3.72	17.08
23MW03D	39.00	55.00	22.91	20.52	8	BEDROCK	1.1	19.42
ERM-1	3.54	13.04	22.49	20.10	2	OVERBURDEN (FILL)	4.25	15.85
ERM-13	5.50	14.55	25.52	23.13	2	OVERBURDEN (FILL)	6.02	17.11
ERM-14	5.50	14.28	25.21	22.82	2	OVERBURDEN (FILL)	5.69	17.13
ERM-15	2.25	11.25	22.63	20.24	2	OVERBURDEN (FILL)	3.46	16.78
ERM-17	2.72	11.72	22.15	19.76	2	OVERBURDEN (FILL)	4.09	15.67
ERM-19	2.81	11.81	22.03	19.64	2	OVERBURDEN (FILL)	4.13	15.51
ERM-2	3.71	13.21	21.46	19.07	2	OVERBURDEN (FILL)	3.81	15.26
HNUS-10	5.00	15.00	23.25	20.86	2	OVERBURDEN (FILL)	8.81	12.05
HNUS-11	5.00	15.00	22.23	19.84	2	OVERBURDEN (FILL)	8.63	11.21
HNUS-12	5.00	15.00	26.47	24.08	2	OVERBURDEN (FILL)	2.68	21.40
HNUS-13	5.00	15.00	25.71	23.32	2	OVERBURDEN (FILL)	1.22	22.10
HNUS-15	5.00	15.00	23.13	20.74	2	OVERBURDEN (FILL)	4.94	15.80
HNUS-2	4.00	14.00	20.70	18.31	2	OVERBURDEN (FILL)	4.82	13.49
HNUS-21	5.00	15.00	22.35	19.96	2	OVERBURDEN (FILL)	7	12.96
HNUS-22	10.00	20.00	27.70	25.31	2	OVERBURDEN (FILL)	9.78	15.53
HNUS-23	7.00	17.00	20.42	18.03	2	OVERBURDEN (FILL)	6.93*	11.10
HNUS-24	5.00	15.00	27.11	24.72	2	OVERBURDEN (FILL)	10.71	14.01
HNUS-4	4.00	14.00	21.24	18.85	2	OVERBURDEN (FILL)	4.32	14.53
HNUS-5	4.00	14.00	21.35	18.96	2	OVERBURDEN (FILL)	4.22	14.74
LOWER SUBASE WELLS								
6MW1S	4.00	14.00	8.63	6.24	2	OVERBURDEN (FILL)	5.9	0.34
6MW2D	77.00	87.00	7.85	5.46	2	OVERBURDEN (ALLUVIUM)	4.51	0.95
6MW2S	3.20	13.20	7.30	4.91	2	OVERBURDEN (FILL/DREDGE)	4.5	0.41
6MW6D	28.00	42.00	12.50	10.11	6	BEDROCK	8.99	1.12
6MW6S	6.00	16.00	12.16	9.77	2	OVERBURDEN (FILL)	8.65	1.12
13MW12	5.30	15.30	9.21	6.82	2	OVERBURDEN (FILL)	6.34	0.48
13MW14	4.80	14.80	7.98	5.59	2	OVERBURDEN (FILL)	5.02	0.57

TABLE 2-3

SUMMARY OF WATER ELEVATIONS - AUGUST 2000
BASEWIDE GROUNDWATER OU RI
NSB-NLON, GROTON, CONNECTICUT

Well Name	Depth to Top of Screen (Feet)	Depth to Bottom of Screen (Feet)	Top of Casing Elevation 1982 Datum	Top of Casing Elevation 1988 Datum	Well Diameter	Aquifer Monitored	Depth to Water (feet) August 2000	Water Elevation (ft-msl)* August 2000
7MW7S	5.50	15.50	46.57	44.18	2	BEDROCK	2.45	41.73
7MW8S	3.00	13.00	42.10	39.71	2	OVERBURDEN (ALLUVIUM)	5.84	33.87
7MW9S	4.00	14.00	37.91	35.52	2	OVERBURDEN (ALLUVIUM)	5.88	29.64
B325-MW1	3.00	13.00	47.23	44.84	2	OVERBURDEN/BEDROCK	3.15	41.69
B325-MW3	2.50	12.50	46.05	43.66	2	OVERBURDEN	1.87	41.79
B325-MW4	4.00	14.00	46.88	44.49	2	OVERBURDEN	4.07	40.42
14MW1S	4.00	14.00	51.44	49.05	2	OVERBURDEN (ALLUVIUM)	5.32	43.73
SOUTHERN REGION WELLS								
8MW1	6.40	16.40	10.15	7.76	2	OVERBURDEN (FILL)	8.70	-0.94
8MW10S	14.50	21.50	21.61	19.22	2	BEDROCK	16.35	2.87
8MW2D	54.00	64.00	9.77	7.38	2	OVERBURDEN (ALLUVIUM)	7.65	-0.27
8MW2S	5.90	15.90	9.43	7.04	2	OVERBURDEN (FILL)	7.03	0.01
8MW3	5.80	15.80	8.96	6.57	2	OVERBURDEN (FILL)	6.53	0.04
8MW4	5.40	14.40	9.34	6.95	2	OVERBURDEN (FILL)	6.67	0.28
8MW5S	6.00	16.00	10.94	8.55	2	OVERBURDEN (FILL)	9.30	-0.75
8MW6D	60.00	70.00	9.62	7.23	2	OVERBURDEN (ALLUVIUM)	7.70	-0.47
8MW6S	4.00	14.00	9.66	7.27	2	OVERBURDEN (FILL)	6.96	0.31
8MW8D	48.00	78.00	19.53	17.14	2	BEDROCK	16.81	0.33
8MW8S	7.00	17.00	19.68	17.29	2	OVERBURDEN (ALLUVIUM)/ BEDROCK	15.24	2.05
8MW9S	14.00	19.00	21.40	19.01	2	BEDROCK	15.93	3.08
15MW1D	36.00	46.00	28.05	25.66	2	OVERBURDEN (ALLUVIUM)	9.98	15.68
15MW1S	5.00	15.00	28.08	25.69	2	OVERBURDEN (ALLUVIUM)	5.58	20.11
15MW2S	5.00	15.00	28.90	26.51	2	OVERBURDEN (ALLUVIUM)	6.36	20.15
15MW3S	5.00	15.00	26.26	23.87	2	OVERBURDEN (ALLUVIUM)	4.49	19.38
23MW01D	50.00	56.50	36.83	34.44	2	BEDROCK	4.65	29.79
23MW01S	6.00	16.00	37.25	34.86	2	OVERBURDEN (ALLUVIUM)	6.64	28.22
23MW02D	18.60	28.50	23.19	20.80	8	BEDROCK	6.11	14.69
23MW02S	4.00	14.00	23.35	20.96	2	OVERBURDEN (ALLUVIUM)	6.09	14.87
23MW03D	39.00	55.00	22.91	20.52	8	BEDROCK	7.19	13.33
23MW04D	65.50	95.50	21.89	19.50	2	BEDROCK	7.44	12.06
23MW04S	45.00	55.00	21.56	19.17	2	OVERBURDEN (ALLUVIUM)	8.11	11.06
HNUS-11	5.00	15.00	22.23	19.84	2	OVERBURDEN (FILL)	8.88	10.96
HNUS-13	5.00	15.00	25.71	23.32	2	OVERBURDEN (FILL)	4.51	18.81
HNUS-2	4.00	14.00	20.70	18.31	2	OVERBURDEN (FILL)	5.47	12.84
HNUS-20	5.00	15.00	22.51	20.12	2	OVERBURDEN (FILL)	8.24	11.88
HNUS-23	7.00	17.00	20.42	18.03	2	OVERBURDEN (FILL)	8.89*	9.14
LOWER SUBASE WELLS								
FOMW14	3.20	10.20	12.68	10.29	2	OVERBURDEN(FILL/ALLUVIUM)	9.35	0.94
MW1-7RI	5.00	9.00	8.11	5.72	2	OVERBURDEN(FILL)	5.50	0.22
MW2-3RI	3.00	8.00	7.78	5.39	2	OVERBURDEN(FILL)	5.94	-0.55
MW2-6RI	3.00	8.00	6.02	3.63	2	OVERBURDEN(FILL)	3.00	0.63
MW3-6RI	3.00	8.00	6.31	3.92	2	OVERBURDEN(FILL)	3.31	0.61
MW3-7RI	3.00	8.00	6.66	4.27	2	OVERBURDEN(FILL)	3.88	0.39
MW4-6RI	3.00	8.00	6.90	4.51	2	OVERBURDEN(FILL)	3.92	0.59
MW4-7RI	3.00	8.00	8.06	5.67	2	OVERBURDEN(FILL)	5.50	0.17
NESO10	4.30	9.30	8.10	5.71	2	OVERBURDEN (ALLUVIUM)	6.02	-0.31
13MW1	7.49	17.49	13.36	10.97	2	OVERBURDEN (ALLUVIUM)	10.11	0.86
13MW10	5.00	15.00	8.44	6.05	2	OVERBURDEN (ALLUVIUM)	6.12	-0.07
13MW12	5.30	15.30	9.21	6.82	2	OVERBURDEN (FILL)	6.38	0.44
13MW14	4.80	14.80	7.98	5.59	2	OVERBURDEN (FILL)	6.60	-1.01
13MW19	5.00	15.00	8.05	5.66	2	OVERBURDEN (FILL)	4.58	1.08
13MW2	7.67	17.67	12.80	10.41	2	OVERBURDEN (ALLUVIUM)	9.49	0.92
13MW20	3.00	13.00	10.45	8.06	2	OVERBURDEN (FILL)	7.12	0.94
13MW21	5.00	15.00	8.70	6.31	2	OVERBURDEN (FILL)	5.33	0.98
13MW3	7.36	17.36	12.89	10.50	2	OVERBURDEN (ALLUVIUM)	9.85	0.65

APPENDIX B.6

SITE 7 - TORPEDO SHOPS SOIL DATA

SUMMARY OF SITE 3 SOIL DATA -AREA A DOWNSTREAM
BASEWIDE GROUDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GRORON, CONNECTICUT

location	3SB14S3	3SB29D0	3SB29D1
matrix	SB	SB	SB
sample	S3SB14S3234	S3SB29D0911	S3SB29D1012
depth	32-34	09-11	10-12
sample_date	6/22/00	6/13/00	6/23/00
validated	TRUE	TRUE	TRUE
cto_proj	312	312	312
proj_manager	CERCONE, D.	CERCONE, D.	CERCONE, D.
Grain Size (%)			
SIEVE # 10		100	
SIEVE # 100		94.44	
SIEVE # 200		66.05	
SIEVE # 4		100	
SIEVE # 40		99.07	
SIEVE # 50		98.61	
SIEVE 1-1/2"		100	
SIEVE 1/2"		100	
SIEVE 3"		100	
SIEVE 3/4"		100	
SIEVE 3/8"		100	
Miscellaneous Parameters			
BULK DENSITY (LB/CU FT)		112.22	
PH		6.96	
POROSITY (N)		0.3306	
SPECIFIC GRAVITY		2.69	
TOTAL ORGANIC CARBON (MG/KG)	109 U		123 U

$$112.22 \frac{lb}{ft^3} \Rightarrow 1.8 \frac{g}{cm^3}$$

$$\left[\text{CONV. FACTOR} = 0.016 \right]$$

APPENDIX B.2

SITE 3 - AREA A DOWNSTREAM SOIL DATA

SUMMARY OF SITE 7 SOIL DATA - TORPEDO SHOPS
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

location	7SB01
matrix	SB
sample	S7SB010912
sacode	NORMAL
depth	09-12
sample_date	6/13/00
validated	TRUE
cto_proj	312
proj_manager	CERCONE, D.
Grain Size (%)	
SIEVE # 10	35.38
SIEVE # 100	27.44
SIEVE # 200	19.49
SIEVE # 4	45.71
SIEVE # 40	30.99
SIEVE # 50	29.82
SIEVE 1-1/2"	100
SIEVE 1/2"	63.77
SIEVE 3"	100
SIEVE 3/4"	100
SIEVE 3/8"	58.69
Miscellaneous Parameters	
BULK DENSITY (LB/FT)	98.77
PH	8.33
POROSITY(N)	0.3736
SPECIFIC GRAVITY	2.53

$98.77 \frac{lb}{ft^3} \Rightarrow 1.58 = 1.6\ g/cm^3$

[CONV. FACTOR = 0.016]

APPENDIX B.17

SITE 23 - TANK FARM SOIL DATA

SUMMARY OF SITE 23 SOIL DATA
TANK FARM
BASEWIDE GROUNDWATER OPERABLE UNIT REMEDIAL INVESTIGATION
NSB-NLON, GROTON, CONNECTICUT

site	23	23
location	23SB02S	23SB04S
matrix	SB	SB
sample	S23SB02S0810	S23SB04S1012
depth	08-10	10-12
sample_date	6/13/00	6/13/00
validated	TRUE	TRUE
cto_proj	312	312
proj_manager	CERCONE, D.	CERCONE, D.
Grain Size (%)		
SIEVE # 10	87.69	97.51
SIEVE # 100	40.62	39.98
SIEVE # 200	25.12	17.01
SIEVE # 4	92.55	98.70
SIEVE # 40	65.74	87.00
SIEVE # 50	57.20	79.31
SIEVE 1-1/2"	100	100
SIEVE 1/2"	98.41	100
SIEVE 3"	100	100
SIEVE 3/4"	100	100
SIEVE 3/8"	97.22	99.57
Miscellaneous Parameters		
BULK DENSITY (LB/CU FT)	90.83	90.75
PH	5.96	7.46
SPECIFIC GRAVITY	2.54	2.68
TOTAL ORGANIC CARBON (MG/KG)	125 U	126 U
POROSITY (N)	0.4263	0.4567

$90.8 \frac{lb}{ft^3} \Rightarrow 1.5 \frac{g}{cm^3}$

$\left[\text{CONV. FACTOR} = 0.016 \right]$

ATTACHMENT B
VAPOR INTRUSION MODELING PRINTOUTS

SITE 2

AREA A UPGRADIENT

RESIDENTIAL

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
67663	1.00E+00	Chloroform

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	190	190	0	0	A	SL	SL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
SL	1.80	0.330	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
1.04E-01	1.00E-05	3.66E-03	25	6,988	334.32	536.40	3.98E+01	7.92E+03	2.3E-05	4.9E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	175	0.227	0.321	0.321	0.220	5.94E-09	0.879	5.22E-09	25.00	0.33	0.010	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	7,544	1.95E-03	8.38E-02	1.76E-04	6.85E-03	0.00E+00	0.00E+00	2.48E-05	1.70E-04	175

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	8.38E+01	0.10	8.33E+01	6.85E-03	4.00E+02	1.29E+132	6.00E-05	5.03E-03	2.3E-05	4.9E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	7.92E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
4.8E-08	9.8E-05

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
2.10E+01	1.02E+04	2.10E+01	7.92E+06	2.10E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	9.00E-01	Trichloroethylene

MORE ↓

ENTER Average soil/groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	190	190	0	0	A	SL	SL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
SL	1.80	0.330	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm-m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	1.1E-04	3.5E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	175	0.227	0.321	0.321	0.220	5.94E-09	0.879	5.22E-09	25.00	0.33	0.010	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	5.20E-03	0.00E+00	0.00E+00	8.83E-06	6.12E-05	175

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	1.95E+02	0.10	8.33E+01	5.20E-03	4.00E+02	8.41E+173	2.18E-05	4.24E-03	1.1E-04	3.5E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.9E-07	1.2E-04

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
4.69E+00	7.74E+03	4.69E+00	1.47E+06	4.69E+00

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	9.00E-01	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
11	15	190	190	0	0	A	SL	SL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SL	1.80	0.330	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	2.0E-06	6.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	175	0.227	0.321	0.321	0.220	5.94E-09	0.879	5.22E-09	25.00	0.33	0.010	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	5.20E-03	0.00E+00	0.00E+00	8.83E-06	6.12E-05	175

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	1.95E+02	0.10	8.33E+01	5.20E-03	4.00E+02	8.41E+173	2.18E-05	4.24E-03	2.0E-06	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
3.5E-09	6.8E-06

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
2.58E+02	1.33E+05	2.58E+02	1.47E+06	2.58E+02

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

INDUSTRIAL

DATA ENTRY SHEET

GW-ADV Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
67663	1.00E+00	Chloroform

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell G28)							
11	15	190	190	0	0	A	SL	SL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SL	1.80	0.330	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
1.04E-01	1.00E-05	3.66E-03	25	6,988	334.32	536.40	3.98E+01	7.92E+03	2.3E-05	4.9E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	175	0.227	0.321	0.321	0.220	5.94E-09	0.879	5.22E-09	25.00	0.33	0.010	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	7,544	1.95E-03	8.38E-02	1.76E-04	6.85E-03	0.00E+00	0.00E+00	2.48E-05	1.70E-04	175

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	8.38E+01	0.10	8.33E+01	6.85E-03	4.00E+02	1.29E+132	1.47E-05	1.23E-03	2.3E-05	4.9E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	7.92E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
6.9E-09	1.7E-05

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
1.44E+02	5.81E+04	1.44E+02	7.92E+06	1.44E+02

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	5.00E-01	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	190	190	0	0	A	SL	SL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
SL	1.80	0.330	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	1.1E-04	3.5E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	175	0.227	0.321	0.321	0.220	5.94E-09	0.879	5.22E-09	25.00	0.33	0.010	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	5.20E-03	0.00E+00	0.00E+00	8.83E-06	6.12E-05	175

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	1.08E+02	0.10	8.33E+01	5.20E-03	4.00E+02	8.41E+173	5.34E-06	5.78E-04	1.1E-04	3.5E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.6E-08	1.1E-05

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
3.22E+01	4.42E+04	3.22E+01	1.47E+06	3.22E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	9.00E-01	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	190	190	0	0	A	SL	SL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
SL	1.80	0.330	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	2.0E-06	6.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	175	0.227	0.321	0.321	0.220	5.94E-09	0.879	5.22E-09	25.00	0.33	0.010	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	5.20E-03	0.00E+00	0.00E+00	8.83E-06	6.12E-05	175

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
15	1.95E+02	0.10	8.33E+01	5.20E-03	4.00E+02	8.41E+173	5.34E-06	1.04E-03	2.0E-06	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
5.1E-10	1.2E-06

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
1.77E+03	7.58E+05	1.77E+03	1.47E+06	1.77E+03

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

SITE 2

AREA A DOWNSTREAM

RESIDENTIAL

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	2.00E+00	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	110	110	0	0	A	SL	SL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
SL	1.80	0.330	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	1.1E-04	3.5E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	95	0.227	0.321	0.321	0.220	5.94E-09	0.879	5.22E-09	25.00	0.33	0.010	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	5.20E-03	0.00E+00	0.00E+00	8.83E-06	3.34E-05	95

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	4.33E+02	0.10	8.33E+01	5.20E-03	4.00E+02	8.41E+173	2.19E-05	9.48E-03	1.1E-04	3.5E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
4.3E-07	2.6E-04

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
4.67E+00	7.70E+03	4.67E+00	1.47E+06	4.67E+00

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	2.00E+00	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
11	15	110	110	0	0	A	SL	SL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SL	1.80	0.330	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	2.0E-06	6.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	95	0.227	0.321	0.321	0.220	5.94E-09	0.879	5.22E-09	25.00	0.33	0.010	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	5.20E-03	0.00E+00	0.00E+00	8.83E-06	3.34E-05	95

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	4.33E+02	0.10	8.33E+01	5.20E-03	4.00E+02	8.41E+173	2.19E-05	9.48E-03	2.0E-06	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
7.8E-09	1.5E-05

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
2.57E+02	1.32E+05	2.57E+02	1.47E+06	2.57E+02

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

INDUSTRIAL

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	2.00E+00	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	110	110	0	0	A	SL	SL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
SL	1.80	0.330	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm-m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	1.1E-04	3.5E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	95	0.227	0.321	0.321	0.220	5.94E-09	0.879	5.22E-09	25.00	0.33	0.010	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	5.20E-03	0.00E+00	0.00E+00	8.83E-06	3.34E-05	95

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
15	4.33E+02	0.10	8.33E+01	5.20E-03	4.00E+02	8.41E+173	5.36E-06	2.32E-03	1.1E-04	3.5E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
6.3E-08	4.5E-05

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
3.20E+01	4.40E+04	3.20E+01	1.47E+06	3.20E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	2.00E+00	Trichloroethylene

MORE ↓

Totals must add up to value of L_{WT} (cell G28)

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	110	110	0	0	A	SL	SL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
SL	1.80	0.330	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	2.0E-06	6.0E-01

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	95	0.227	0.321	0.321	0.220	5.94E-09	0.879	5.22E-09	25.00	0.33	0.010	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	5.20E-03	0.00E+00	0.00E+00	8.83E-06	3.34E-05	95

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	4.33E+02	0.10	8.33E+01	5.20E-03	4.00E+02	8.41E+173	5.36E-06	2.32E-03	2.0E-06	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.1E-09	2.7E-06

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
1.76E+03	7.54E+05	1.76E+03	1.47E+06	1.76E+03

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

SITE 2

AREA A WETLANDS

RESIDENTIAL

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
127184	1.40E+00	Tetrachloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell G28)							
11	15	65	65	0	0	A	CL	CL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
CL	1.48	0.442	0.168	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
7.20E-02	8.20E-06	1.84E-02	25	8,288	394.40	620.20	1.55E+02	2.00E+02	5.9E-06	2.8E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	50	0.274	0.321	0.321	0.245	1.26E-09	0.865	1.09E-09	46.88	0.442	0.067	0.375	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	9,543	8.30E-03	3.56E-01	1.76E-04	4.95E-03	0.00E+00	0.00E+00	4.97E-05	5.29E-05	50

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	4.98E+02	0.10	8.33E+01	4.95E-03	4.00E+02	8.79E+182	6.54E-05	3.26E-02	5.9E-06	2.8E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	2.00E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
7.9E-08	1.1E-04

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
1.77E+01	1.26E+04	1.77E+01	2.00E+05	1.77E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	1.40E+00	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
11	15	65	65	0	0	A	CL	CL		

Thickness columns: Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
CL	1.48	0.442	0.168	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Target risk and hazard quotient: Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	1.1E-04	3.5E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	50	0.274	0.321	0.321	0.245	1.26E-09	0.865	1.09E-09	46.88	0.442	0.067	0.375	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	5.43E-03	0.00E+00	0.00E+00	5.78E-05	6.16E-05	50

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	3.03E+02	0.10	8.33E+01	5.43E-03	4.00E+02	5.33E+166	7.59E-05	2.30E-02	1.1E-04	3.5E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.0E-06	6.3E-04

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
1.35E+00	2.22E+03	1.35E+00	1.47E+06	1.35E+00

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	1.40E+00	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
11	15	65	65	0	0	A	CL	CL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
CL	1.48	0.442	0.168	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	2.0E-06	6.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	50	0.274	0.321	0.321	0.245	1.26E-09	0.865	1.09E-09	46.88	0.442	0.067	0.375	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	5.43E-03	0.00E+00	0.00E+00	5.78E-05	6.16E-05	50

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	3.03E+02	0.10	8.33E+01	5.43E-03	4.00E+02	5.33E+166	7.59E-05	2.30E-02	2.0E-06	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.9E-08	3.7E-05

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
7.41E+01	3.81E+04	7.41E+01	1.47E+06	7.41E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

INDUSTRIAL

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
127184	1.40E+00	Tetrachloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	65	65	0	0	A	CL	CL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
Lookup Soil Parameters				Lookup Soil Parameters				Lookup Soil Parameters			
CL	1.48	0.442	0.168	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
7.20E-02	8.20E-06	1.84E-02	25	8,288	394.40	620.20	1.55E+02	2.00E+02	5.9E-06	2.8E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm³/cm³)	Stratum B soil air-filled porosity, θ_a^B (cm³/cm³)	Stratum C soil air-filled porosity, θ_a^C (cm³/cm³)	Stratum A effective total fluid saturation, S_{te} (cm³/cm³)	Stratum A soil intrinsic permeability, k_i (cm²)	Stratum A soil relative air permeability, k_{rg} (cm²)	Stratum A soil effective vapor permeability, k_v (cm²)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm³/cm³)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm³/cm³)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm³/cm³)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	50	0.274	0.321	0.321	0.245	1.26E-09	0.865	1.09E-09	46.88	0.442	0.067	0.375	4,000

Bldg. ventilation rate, $Q_{building}$ (cm³/s)	Area of enclosed space below grade, A_B (cm²)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m³/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm²/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm²/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm²/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm²/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm²/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	9,543	8.30E-03	3.56E-01	1.76E-04	4.95E-03	0.00E+00	0.00E+00	4.97E-05	5.29E-05	50

Convection path length, L_p (cm)	Source vapor conc., C_{source} (μg/m³)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm³/s)	Crack effective diffusion coefficient, D^{crack} (cm²/s)	Area of crack, A_{crack} (cm²)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (μg/m³)	Unit risk factor, URF (μg/m³)⁻¹	Reference conc., RfC (mg/m³)
15	4.98E+02	0.10	8.33E+01	4.95E-03	4.00E+02	8.79E+182	1.60E-05	7.98E-03	5.9E-06	2.8E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	2.00E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.2E-08	2.0E-05

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
1.22E+02	7.17E+04	1.22E+02	2.00E+05	1.22E+02

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	1.40E+00	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
11	15	65	65	0	0	A	CL	CL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
CL	1.48	0.442	0.168	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	1.1E-04	3.5E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	*Thickness of* capillary zone, L_{cz} (cm)	Total *porosity in* capillary zone, n_{cz} (cm^3/cm^3)	Air-filled *porosity in* capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	50	0.274	0.321	0.321	0.245	1.26E-09	0.865	1.09E-09	46.88	0.442	0.067	0.375	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total *overall* effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	5.43E-03	0.00E+00	0.00E+00	5.78E-05	6.16E-05	50

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	3.03E+02	0.10	8.33E+01	5.43E-03	4.00E+02	5.33E+166	1.86E-05	5.63E-03	1.1E-04	3.5E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.5E-07	1.1E-04

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
9.24E+00	1.27E+04	9.24E+00	1.47E+06	9.24E+00

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	1.40E+00	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	65	65	0	0	A	CL	CL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C' soil water-filled porosity, θ_w^C (cm³/cm³)
CL	1.48	0.442	0.168	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	2.0E-06	6.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	50	0.274	0.321	0.321	0.245	1.26E-09	0.865	1.09E-09	46.88	0.442	0.067	0.375	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	5.43E-03	0.00E+00	0.00E+00	5.78E-05	6.16E-05	50

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	3.03E+02	0.10	8.33E+01	5.43E-03	4.00E+02	5.33E+166	1.86E-05	5.63E-03	2.0E-06	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
2.8E-09	6.4E-06

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
5.08E+02	2.18E+05	5.08E+02	1.47E+06	5.08E+02

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

SITE 3

RESIDENTIAL

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
67663	1.50E+01	Chloroform

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
11	15	110	110	0	0	A	S	S		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
Lookup Soil Parameters				Lookup Soil Parameters				Lookup Soil Parameters			
S	1.80	0.330	0.054	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
1.04E-01	1.00E-05	3.66E-03	25	6,988	334.32	536.40	3.98E+01	7.92E+03	2.3E-05	4.9E-02

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	95	0.276	0.321	0.321	0.004	9.94E-08	0.998	9.92E-08	17.05	0.33	0.077	0.253	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m³/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	7,544	1.95E-03	8.38E-02	1.76E-04	1.31E-02	0.00E+00	0.00E+00	1.96E-04	1.02E-03	95

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	1.26E+03	0.10	8.33E+01	1.31E-02	4.00E+02	8.21E+68	5.93E-04	7.46E-01	2.3E-05	4.9E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	7.92E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
7.0E-06	1.5E-02

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
2.13E+00	1.03E+03	2.13E+00	7.92E+06	2.13E+00

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	7.00E+00	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	110	110	0	0	A	S	S		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
S	1.80	0.330	0.054	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	1.1E-04	3.5E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	95	0.276	0.321	0.321	0.004	9.94E-08	0.998	9.92E-08	17.05	0.33	0.077	0.253	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	9.97E-03	0.00E+00	0.00E+00	1.45E-04	7.55E-04	95

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	1.52E+03	0.10	8.33E+01	9.97E-03	4.00E+02	5.28E+90	4.52E-04	6.85E-01	1.1E-04	3.5E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
3.1E-05	1.9E-02

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
2.26E-01	3.73E+02	2.26E-01	1.47E+06	2.26E-01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	7.00E+00	Trichloroethylene

MORE ↓

Totals must add up to value of L_{WT} (cell G28)

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	110	110	0	0	A	S	S		

MORE ↓

ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
Lookup Soil Parameters				Lookup Soil Parameters				Lookup Soil Parameters			
S	1.80	0.330	0.054	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	2.0E-06	6.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	95	0.276	0.321	0.321	0.004	9.94E-08	0.998	9.92E-08	17.05	0.33	0.077	0.253	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	9.97E-03	0.00E+00	0.00E+00	1.45E-04	7.55E-04	95

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	1.52E+03	0.10	8.33E+01	9.97E-03	4.00E+02	5.28E+90	4.52E-04	6.85E-01	2.0E-06	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
5.6E-07	1.1E-03

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
1.24E+01	6.40E+03	1.24E+01	1.47E+06	1.24E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
75014	1.00E+01	Vinyl chloride (chloroethene)

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell G28)							
11	15	110	110	0	0	A	S	S		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
S	1.80	0.330	0.054	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
1.06E-01	1.23E-05	2.69E-02	25	5,250	259.25	432.00	1.86E+01	8.80E+03	4.4E-06	1.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	95	0.276	0.321	0.321	0.004	9.94E-08	0.998	9.92E-08	17.05	0.33	0.077	0.253	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	4,989	1.78E-02	7.63E-01	1.76E-04	1.34E-02	0.00E+00	0.00E+00	1.90E-04	9.95E-04	95

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	7.63E+03	0.10	8.33E+01	1.34E-02	4.00E+02	4.11E+67	5.78E-04	4.41E+00	4.4E-06	1.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	8.80E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
8.0E-06	4.2E-02

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
1.25E+00	2.36E+02	1.25E+00	8.80E+06	1.25E+00

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

INDUSTRIAL

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
67663	1.50E+01	Chloroform

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
			Totals must add up to value of L_{WT} (cell G28)							
11	15	110	110	0	0	A	S	S		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
S	1.80	0.330	0.054	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
1.04E-01	1.00E-05	3.66E-03	25	6,988	334.32	536.40	3.98E+01	7.92E+03	2.3E-05	4.9E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	95	0.276	0.321	0.321	0.004	9.94E-08	0.998	9.92E-08	17.05	0.33	0.077	0.253	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	7,544	1.95E-03	8.38E-02	1.76E-04	1.31E-02	0.00E+00	0.00E+00	1.96E-04	1.02E-03	95

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	1.26E+03	0.10	8.33E+01	1.31E-02	4.00E+02	8.21E+68	1.45E-04	1.83E-01	2.3E-05	4.9E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	7.92E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.0E-06	2.6E-03

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
1.46E+01	5.87E+03	1.46E+01	7.92E+06	1.46E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	7.00E+00	Trichloroethylene

MORE ↓

Totals must add up to value of L_{WT} (cell G28)

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
11	15	110	110	0	0	A	S	S		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
S	1.80	0.330	0.054	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	1.1E-04	3.5E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	95	0.276	0.321	0.321	0.004	9.94E-08	0.998	9.92E-08	17.05	0.33	0.077	0.253	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	9.97E-03	0.00E+00	0.00E+00	1.45E-04	7.55E-04	95

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	1.52E+03	0.10	8.33E+01	9.97E-03	4.00E+02	5.28E+90	1.11E-04	1.68E-01	1.1E-04	3.5E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
4.5E-06	3.3E-03

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
1.55E+00	2.13E+03	1.55E+00	1.47E+06	1.55E+00

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	7.00E+00	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
11	15	110	110	0	0	A	S	S		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
S	1.80	0.330	0.054	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	2.0E-06	6.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	95	0.276	0.321	0.321	0.004	9.94E-08	0.998	9.92E-08	17.05	0.33	0.077	0.253	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	9.97E-03	0.00E+00	0.00E+00	1.45E-04	7.55E-04	95

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	1.52E+03	0.10	8.33E+01	9.97E-03	4.00E+02	5.28E+90	1.11E-04	1.68E-01	2.0E-06	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
8.2E-08	1.9E-04

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
8.53E+01	3.66E+04	8.53E+01	1.47E+06	8.53E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
75014	1.00E+01	Vinyl chloride (chloroethene)

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	110	110	0	0	A	S	S		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
S	1.80	0.330	0.054	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
1.06E-01	1.23E-05	2.69E-02	25	5,250	259.25	432.00	1.86E+01	8.80E+03	4.4E-06	1.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	95	0.276	0.321	0.321	0.004	9.94E-08	0.998	9.92E-08	17.05	0.33	0.077	0.253	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	4,989	1.78E-02	7.63E-01	1.76E-04	1.34E-02	0.00E+00	0.00E+00	1.90E-04	9.95E-04	95

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	7.63E+03	0.10	8.33E+01	1.34E-02	4.00E+02	4.11E+67	1.42E-04	1.08E+00	4.4E-06	1.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	8.80E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.2E-06	7.4E-03

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
8.60E+00	1.35E+03	8.60E+00	8.80E+06	8.60E+00

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

SITE 7

RESIDENTIAL

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	1.00E+00	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	150	150	0	0	A	LS	LS		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
LS	1.60	0.370	0.076	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	1.1E-04	3.5E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	135	0.294	0.321	0.321	0.084	1.63E-08	0.955	1.55E-08	18.75	0.37	0.067	0.303	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	9.79E-03	0.00E+00	0.00E+00	7.83E-05	5.37E-04	135

Convection path length, L_p (cm)	Source vapor conc., C_{source} (µg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m^3)	Unit risk factor, URF (µg/m^3)$^{-1}$	Reference conc., RfC (mg/m^3)
15	2.17E+02	0.10	8.33E+01	9.79E-03	4.00E+02	2.57E+92	2.37E-04	5.13E-02	1.1E-04	3.5E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
2.3E-06	1.4E-03

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
4.31E-01	7.11E+02	4.31E-01	1.47E+06	4.31E-01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	1.00E+00	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	150	150	0	0	A	LS	LS		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
LS	1.60	0.370	0.076	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	2.0E-06	6.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	135	0.294	0.321	0.321	0.084	1.63E-08	0.955	1.55E-08	18.75	0.37	0.067	0.303	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	9.79E-03	0.00E+00	0.00E+00	7.83E-05	5.37E-04	135

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	2.17E+02	0.10	8.33E+01	9.79E-03	4.00E+02	2.57E+92	2.37E-04	5.13E-02	2.0E-06	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
4.2E-08	8.2E-05

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
2.37E+01	1.22E+04	2.37E+01	1.47E+06	2.37E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

INDUSTRIAL

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	1.00E+00	Trichloroethylene

MORE ↓

ENTER Average soil/groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	150	150	0	0	A	LS	LS		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
LS	1.60	0.370	0.076	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	1.1E-04	3.5E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	135	0.294	0.321	0.321	0.084	1.63E-08	0.955	1.55E-08	18.75	0.37	0.067	0.303	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	9.79E-03	0.00E+00	0.00E+00	7.83E-05	5.37E-04	135

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	2.17E+02	0.10	8.33E+01	9.79E-03	4.00E+02	2.57E+92	5.81E-05	1.26E-02	1.1E-04	3.5E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
3.4E-07	2.5E-04

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
2.96E+00	4.06E+03	2.96E+00	1.47E+06	2.96E+00

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	1.00E+00	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm) — Totals must add up to value of L_{WT} (cell G28)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
11	15	150	150	0	0	A	LS	LS		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
LS	1.60	0.370	0.076	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	2.0E-06	6.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	135	0.294	0.321	0.321	0.084	1.63E-08	0.955	1.55E-08	18.75	0.37	0.067	0.303	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	9.79E-03	0.00E+00	0.00E+00	7.83E-05	5.37E-04	135

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	2.17E+02	0.10	8.33E+01	9.79E-03	4.00E+02	2.57E+92	5.81E-05	1.26E-02	2.0E-06	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
6.2E-09	1.4E-05

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
1.63E+02	6.97E+04	1.63E+02	1.47E+06	1.63E+02

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

SITE 15

RESIDENTIAL

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
67663	3.00E+00	Chloroform

MORE ↓

Totals must add up to value of L_{WT} (cell G28)

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	200	200	0	0	A	LS	LS		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
LS	1.50	0.450	0.076	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
1.04E-01	1.00E-05	3.66E-03	25	6,988	334.32	536.40	3.98E+01	7.92E+03	2.3E-05	4.9E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	185	0.374	0.321	0.321	0.067	1.63E-08	0.964	1.57E-08	18.75	0.45	0.147	0.303	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	7,544	1.95E-03	8.38E-02	1.76E-04	1.94E-02	0.00E+00	0.00E+00	8.86E-04	6.22E-03	185

Convection path length, L_p (cm)	Source vapor conc., C_{source} (μg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (μg/m^3)	Unit risk factor, URF (μg/m^3)$^{-1}$	Reference conc., RfC (mg/m^3)
15	2.52E+02	0.10	8.33E+01	1.94E-02	4.00E+02	3.87E+46	1.47E-03	3.71E-01	2.3E-05	4.9E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	7.92E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
3.5E-06	7.3E-03

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
8.56E-01	4.14E+02	8.56E-01	7.92E+06	8.56E-01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

INDUSTRIAL

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
67663	3.00E+00	Chloroform

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	200	200	0	0	A	LS	LS		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
LS	1.50	0.450	0.076	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
1.04E-01	1.00E-05	3.66E-03	25	6,988	334.32	536.40	3.98E+01	7.92E+03	2.3E-05	4.9E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	185	0.374	0.321	0.321	0.067	1.63E-08	0.964	1.57E-08	18.75	0.45	0.147	0.303	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	7,544	1.95E-03	8.38E-02	1.76E-04	1.94E-02	0.00E+00	0.00E+00	8.86E-04	6.22E-03	185

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	2.52E+02	0.10	8.33E+01	1.94E-02	4.00E+02	3.87E+46	3.61E-04	9.08E-02	2.3E-05	4.9E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	7.92E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
5.1E-07	1.3E-03

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
5.87E+00	2.36E+03	5.87E+00	7.92E+06	5.87E+00

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

SITE 20

RESIDENTIAL

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	5.02E+00	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	140	140	0	0	A	SL	SL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
SL	1.60	0.370	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	1.1E-04	3.5E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	*Source-* building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	125	0.267	0.321	0.321	0.193	5.94E-09	0.895	5.32E-09	25.00	0.37	0.050	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	7.10E-03	0.00E+00	0.00E+00	3.42E-05	1.68E-04	125

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	1.09E+03	0.10	8.33E+01	7.10E-03	4.00E+02	2.28E+127	8.26E-05	8.98E-02	1.1E-04	3.5E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
4.1E-06	2.5E-03

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
1.24E+00	2.04E+03	1.24E+00	1.47E+06	1.24E+00

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	5.02E+00	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
11	15	140	140	0	0	A	SL	SL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SL	1.60	0.370	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	2.0E-06	6.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	125	0.267	0.321	0.321	0.193	5.94E-09	0.895	5.32E-09	25.00	0.37	0.050	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	7.10E-03	0.00E+00	0.00E+00	3.42E-05	1.68E-04	125

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	1.09E+03	0.10	8.33E+01	7.10E-03	4.00E+02	2.28E+127	8.26E-05	8.98E-02	2.0E-06	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
7.4E-08	1.4E-04

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
6.80E+01	3.50E+04	6.80E+01	1.47E+06	6.80E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

INDUSTRIAL

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	5.02E+00	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	140	140	0	0	A	SL	SL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, $\rho_b{}^A$ (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, $\theta_w{}^A$ (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, $\rho_b{}^B$ (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, $\theta_w{}^B$ (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, $\rho_b{}^C$ (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, $\theta_w{}^C$ (cm³/cm³)
SL	1.60	0.370	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	1.1E-04	3.5E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	125	0.267	0.321	0.321	0.193	5.94E-09	0.895	5.32E-09	25.00	0.37	0.050	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	7.10E-03	0.00E+00	0.00E+00	3.42E-05	1.68E-04	125

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	1.09E+03	0.10	8.33E+01	7.10E-03	4.00E+02	2.28E+127	2.02E-05	2.20E-02	1.1E-04	3.5E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
5.9E-07	4.3E-04

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
8.48E+00	1.17E+04	8.48E+00	1.47E+06	8.48E+00

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	5.02E+00	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	140	140	0	0	A	SL	SL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
SL	1.60	0.370	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	2.0E-06	6.0E-01

END

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	125	0.267	0.321	0.321	0.193	5.94E-09	0.895	5.32E-09	25.00	0.37	0.050	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	7.10E-03	0.00E+00	0.00E+00	3.42E-05	1.68E-04	125

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	1.09E+03	0.10	8.33E+01	7.10E-03	4.00E+02	2.28E+127	2.02E-05	2.20E-02	2.0E-06	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.1E-08	2.5E-05

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
4.67E+02	2.00E+05	4.67E+02	1.47E+06	4.67E+02

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

SITE 23

RESIDENTIAL

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
67663	3.00E+00	Chloroform

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	210	210	0	0	A	SL	SL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
SL	1.50	0.450	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
1.04E-01	1.00E-05	3.66E-03	25	6,988	334.32	536.40	3.98E+01	7.92E+03	2.3E-05	4.9E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	195	0.347	0.321	0.321	0.156	5.94E-09	0.917	5.45E-09	25.00	0.45	0.130	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	7,544	1.95E-03	8.38E-02	1.76E-04	1.51E-02	0.00E+00	0.00E+00	5.93E-04	3.65E-03	195

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	2.52E+02	0.10	8.33E+01	1.51E-02	4.00E+02	6.17E+59	9.46E-04	2.38E-01	2.3E-05	4.9E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	7.92E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
2.2E-06	4.7E-03

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
1.33E+00	6.44E+02	1.33E+00	7.92E+06	1.33E+00

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	5.00E-01	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
11	15	210	210	0	0	A	SL	SL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SL	1.50	0.450	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	1.1E-04	3.5E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	195	0.347	0.321	0.321	0.156	5.94E-09	0.917	5.45E-09	25.00	0.45	0.130	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	1.15E-02	0.00E+00	0.00E+00	4.45E-04	2.75E-03	195

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	1.08E+02	0.10	8.33E+01	1.15E-02	4.00E+02	5.15E+78	7.47E-04	8.09E-02	1.1E-04	3.5E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
3.7E-06	2.2E-03

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
1.37E-01	2.26E+02	1.37E-01	1.47E+06	1.37E-01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	5.00E-01	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
			Totals must add up to value of L_{WT} (cell G28)							
11	15	210	210	0	0	A	SL	SL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
SL	1.50	0.450	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	244	0.1	0.25	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	2.0E-06	6.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
9.46E+08	195	0.347	0.321	0.321	0.156	5.94E-09	0.917	5.45E-09	25.00	0.45	0.130	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
1.69E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	1.15E-02	0.00E+00	0.00E+00	4.45E-04	2.75E-03	195

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	1.08E+02	0.10	8.33E+01	1.15E-02	4.00E+02	5.15E+78	7.47E-04	8.09E-02	2.0E-06	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
6.6E-08	1.3E-04

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
7.52E+00	3.87E+03	7.52E+00	1.47E+06	7.52E+00

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

INDUSTRIAL

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
67663	3.00E+00	Chloroform

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
			Totals must add up to value of L_{WT} (cell G28)							
11	15	210	210	0	0	A	SL	SL		

MORE ↓

ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
Lookup Soil Parameters				Lookup Soil Parameters				Lookup Soil Parameters			
SL	1.50	0.450	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
1.04E-01	1.00E-05	3.66E-03	25	6,988	334.32	536.40	3.98E+01	7.92E+03	2.3E-05	4.9E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	195	0.347	0.321	0.321	0.156	5.94E-09	0.917	5.45E-09	25.00	0.45	0.130	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	7,544	1.95E-03	8.38E-02	1.76E-04	1.51E-02	0.00E+00	0.00E+00	5.93E-04	3.65E-03	195

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	2.52E+02	0.10	8.33E+01	1.51E-02	4.00E+02	6.17E+59	2.32E-04	5.83E-02	2.3E-05	4.9E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	7.92E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
3.3E-07	8.1E-04

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
9.15E+00	3.68E+03	9.15E+00	7.92E+06	9.15E+00

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	5.00E-01	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	210	210	0	0	A	SL	SL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
SL	1.50	0.450	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	1.1E-04	3.5E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	195	0.347	0.321	0.321	0.156	5.94E-09	0.917	5.45E-09	25.00	0.45	0.130	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	1.15E-02	0.00E+00	0.00E+00	4.45E-04	2.75E-03	195

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
15	1.08E+02	0.10	8.33E+01	1.15E-02	4.00E+02	5.15E+78	1.83E-04	1.98E-02	1.1E-04	3.5E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
5.3E-07	3.9E-04

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
9.38E-01	1.29E+03	9.38E-01	1.47E+06	9.38E-01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	5.00E-01	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
11	15	210	210	0	0	A	SL	SL		

Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
SL	1.50	0.450	0.103	S	1.66	0.375	0.054	S	1.66	0.375	0.054

Lookup Soil Parameters

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	1000	1000	300	0.1	0.83	5

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3$)$^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	2.0E-06	6.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	195	0.347	0.321	0.321	0.156	5.94E-09	0.917	5.45E-09	25.00	0.45	0.130	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
6.92E+04	1.06E+06	3.77E-04	15	8,544	5.05E-03	2.17E-01	1.76E-04	1.15E-02	0.00E+00	0.00E+00	4.45E-04	2.75E-03	195

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	1.08E+02	0.10	8.33E+01	1.15E-02	4.00E+02	5.15E+78	1.83E-04	1.98E-02	2.0E-06	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
9.7E-09	2.3E-05

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

PRG SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (mg/L)	Indoor exposure groundwater conc., noncarcinogen (mg/L)	Risk-based indoor exposure groundwater conc., (mg/L)	Pure component water solubility, S (mg/L)	Final indoor exposure groundwater conc., (mg/L)
5.16E+01	2.21E+04	5.16E+01	1.47E+06	5.16E+01

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)
MESSAGE: The values of Csource and Cbuilding on the INTERCALCS worksheet are based on unity and do not represent actual values.

SCROLL DOWN TO "END"

END

APPENDIX F

HUMAN HEALTH RISK ASSESSMENT
RAGS PART D TABLES

LIST OF TABLES
RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
SITES 3, 7, 14, 15, 18, AND 20 GROUNDWATER RECORD OF DECISION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 3	*1,1,2-Trichloroethane*	--	--	1.6E-10	--	1.6E-10	Blood	--	--	0.00005	0.00005
			Trichloroethene	--	--	5.5E-11	--	5.5E-11	Liver	--	--	0.000	0.000
			Vinyl Chloride	--	--	1.5E-09	--	1.5E-09	Liver	--	--	0.00005	0.00005
			Benzo(a)pyrene	--	--	2.6E-07	--	2.6E-07	NA	--	--	--	--
			Dibenzo(a,h)anthracene	--	--	9.2E-07	--	9.2E-07	NA	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	--	7.3E-08	--	7.3E-08	NA	--	--	--	--
			Alpha-BHC	--	--	1.8E-09	--	1.8E-09	NA	--	--	0.00004	0.00004
			Arsenic	--	--	6.5E-09	--	6.5E-09	Skin, CVS	--	--	0.001	0.001
			Chemical Total	--	--	1.3E-06	--	1.3E-06		--	--	0.001	0.001
		Exposure Point Total						1.3E-06					0.001
	Exposure Medium Total							1.3E-06					0.001
Medium Total								1.3E-06					0.001
Receptor Total							Receptor Risk Total	1.3E-06				Receptor HI Total	0.001

From Basewide Groundwater Operable Unit Remedial Investigation Update/Feasibility Study (TtNUS, 2004).

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
SITES 3, 7, 14, 15, 18, AND 20 GROUNDWATER RECORD OF DECISION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 3	1,1,2-Trichloroethane	1.3E-06	--	9.2E-08	--	1.4E-06	Blood	0.01	--	0.0009	0.01
			Trichloroethene	2.6E-07	--	3.2E-08	--	2.9E-07	Liver	0.009	--	0.001	0.01
			Vinyl Chloride	1.7E-05	--	6.4E-07	--	1.8E-05	Liver	0.02	--	0.0007	0.02
			Benzo(a)pyrene	1.1E-05	--	1.8E-04	--	1.9E-04	NA	--	--	--	--
			Dibenzo(a,h)anthracene	2.6E-05	--	6.3E-04	--	6.6E-04	NA	--	--	--	--
			Indeno(1,2,3-cd)pyrene	3.0E-06	--	5.0E-05	--	5.3E-05	NA	--	--	--	--
			Alpha-BHC	2.1E-06	--	1.2E-06	--	3.3E-06	NA	0.002	--	0.0009	0.002
			Arsenic	4.5E-04	--	1.1E-06	--	4.5E-04	Skin, CVS	2.3	--	0.006	2.3
			Chemical Total	5.1E-04	--	8.6E-04	--	1.4E-03		2.4	--	0.01	2.4
		Exposure Point Total						1.4E-03					2.4
	Exposure Medium Total							1.4E-03					2.4
	Groundwater	Site 3	1,1,2-Trichloroethane	--	1.3E-06	--	--	1.3E-06	Blood	--	0.01	--	0.01
			Trichloroethene	--	2.6E-07	--	--	2.6E-07	Liver	--	--	--	--
			Vinyl Chloride	--	1.7E-05	--	--	1.7E-05	Liver	--	0.02	--	0.02
			Benzo(a)pyrene	--	--	--	--	--	NA	--	--	--	--
			Dibenzo(a,h)anthracene	--	--	--	--	--	NA	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	--	--	--	--	NA	--	--	--	--
			Alpha-BHC	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	--	--	--	--	Skin, CVS	--	--	--	--
			Chemical Total	--	1.9E-05	--	--	1.9E-05		--	0.04	--	0.04
		Exposure Point Total						1.9E-05					0.04
	Exposure Medium Total							1.4E-03					2.4
Medium Total								1.4E-03					2.4
Receptor Total							Receptor Risk Total	1.4E-03				Receptor HI Total	2.4

Note:
Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.
From Basewide Groundwater Operable Unit Remedial Investigation Update/Feasibility Study (TtNUS, 2004).

Total Blood HI	0.03
Total CVS HI	2.3
Total Liver HI	0.05
Total Skin HI	2.3

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
SITES 3, 7, 14, 15, 18, AND 20 GROUNDWATER RECORD OF DECISION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Torpedo Shops (Site 7)	1,3-Dichlorobenzene	- -	--	- -	--	- -	None Specified	--	- -	0.002	0.002
			1,4-Dichlorobenzene	- -	--	2.0E-08	--	2.0E-08	None Specified	--	- -	0.002	0.002
			Chlorobenzene	- -	--	- -	--	- -	Liver	--	- -	0.003	0.003
			Benzene	- -	--	3.2E-10	--	3.2E-10	None Specified	--	- -	0.0001	0.0001
			Trichloroethene	- -	--	6.5E-10	--	6.5E-10	Liver	--	- -	0.0007	0.0007
			Bis(2-ethylhexyl)phthalate	- -	--	6.8E-08	--	6.8E-08	Liver	--	- -	0.02	0.02
			Hexachlorobenzene	- -	--	3.3E-07	--	3.3E-07	Liver	--	- -	0.02	0.02
			Arsenic	- -	--	- -	--	- -	Skin	--	- -	--	--
			Barium	- -	--	- -	--	- -	CVS, Fetus	--	- -	--	--
			Chromium	- -	--	- -	--	- -	None Specified	--	- -	0.04	0.04
			Lead	- -	--	- -	--	- -	NA	--	- -	- -	--
			Vanadium	- -	--	- -	--	- -	None Specified	--	- -	0.01	0.01
			Chemical Total	- -	--	4.2E-07	--	4.2E-07		--	- -	0.09	0.09
		Exposure Point Total						4.2E-07					0.09
	Exposure Medium Total							4.2E-07					0.09
Medium Total								4.2E-07					0.09
Receptor Total							Receptor Risk Total	4.2E-07				Receptor HI Total	0.09

From Basewide Groundwater Operable Unit Remedial Investigaiton Report, TtNUS (2002a).

TABLE 9.4.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
SITES 3, 7, 14, 15, 18, AND 20 GROUNDWATER RECORD OF DECISION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Torpedo Shops (Site 7)	1,3-Dichlorobenzene	--	--	--	--	--	None Specified	0.05	--	0.04	0.09
			1,4-Dichlorobenzene	2.6E-05	--	1.3E-05	--	3.9E-05	None Specified	0.08	--	0.04	0.1
			Chlorobenzene	--	--	--	--	--	Liver	0.2	--	0.06	0.3
			Benzene	1.3E-06		1.5E-07		1.4E-06	None Specified	0.02	--	0.002	0.02
			Trichloroethene	3.0E-06		3.8E-07		3.3E-06	Liver	0.1	--	0.01	0.1
			Bis(2-ethylhexyl)phthalate	3.1E-05		4.7E-05		7.9E-05	Liver	0.3	--	0.4	0.7
			Hexachlorobenzene	5.6E-05		2.3E-04		2.9E-04	Liver	0.1	--	0.4	0.5
			Arsenic	2.0E-04		--		2.0E-04	Skin	1.0	--	--	1.0
			Barium	--	--	--	--	--	CVS, Fetus	0.2	--	--	0.2
			Chromium	--	--	--	--	--	None Specified	1.2	--	0.2	1.4
			Lead	--	--	--	--	--	NA	--	--	--	--
			Vanadium	--	--	--	--	--	None Specified	0.6	--	0.06	0.6
			Chemical Total	3.2E-04	--	2.9E-04	--	6.1E-04		3.8	--	1.3	5.1
		Exposure Point Total						6.1E-04					5.1
	Exposure Medium Total							6.1E-04					5.1
	Groundwater	Torpedo Shops (Site 7)	1,3-Dichlorobenzene	--	--	--	--	--	None Specified	--	0.05	--	0.05
			1,4-Dichlorobenzene	--	2.6E-05	--	--	2.6E-05	None Specified	--	0.08	--	0.08
			Chlorobenzene	--	--	--	--	--	Liver		0.2		0.2
			Benzene	--	1.3E-06	--	--	1.3E-06	None Specified		0.02		0.02
			Trichloroethene	--	3.0E-06	--	--	3.0E-06	Liver		0.1		0.1
			Bis(2-ethylhexyl)phthalate	--	--	--	--	--	Liver		--		--
			Hexachlorobenzene	--	--	--	--	--	Liver		--		--
			Arsenic	--	--	--	--	--	Skin	--	--	--	--
			Barium	--	--	--	--	--	CVS, Fetus	--	--	--	--
			Chromium	--	--	--	--	--	None Specified	--	--	--	--
			Lead	--	--	--	--	--	NA	--	--	--	--
			Vanadium	--	--	--	--	--	None Specified	--	--	--	--
			Chemical Total	--	3.0E-05	--	--	3.0E-05		--	0.5	--	0.5
		Exposure Point Total						3.0E-05					0.5
	Exposure Medium Total							3.0E-05					0.5
Medium Total								6.4E-04					5.6
Receptor Total							Receptor Risk Total	6.4E-04				Receptor HI Total	5.6

Note:
Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.
From Basewide Groundwater Operable Unit Remedial Investigation Report, TtNUS (2002a).

Total Skin HI	1.0
Total Liver HI	1.9
Total CVS HI	0.2
Total Fetus HI	0.2
Total None Specified HI	2.4

8/29/2008

TABLE 9.5.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
SITES 3, 7, 14, 15, 18, AND 20 GROUNDWATER RECORD OF DECISION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 15	Cadmium	- -	--	- -	--	- -	Kidney	--	- -	0.002	0.002
			Chemical Total	- -	--	- -	--	- -		--	- -	0.002	0.002
		Exposure Point Total						- -					0.002
	Exposure Medium Total							- -					0.002
Medium Total								- -					0.002
Receptor Total							Receptor Risk Total	- -				Receptor HI Total	0.002

TABLE 9.6.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
SITES 3, 7, 14, 15, 18, AND 20 GROUNDWATER RECORD OF DECISION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 15	Cadmium	--	--	--	--	--	Kidney	0.2	--	0.01	0.3
			Chemical Total	--	--	--	--	--		0.2	--	0.01	0.3
		Exposure Point Total						--					0.3
	Exposure Medium Total							--					0.3
	Groundwater	Site 15	Cadmium	--	--	--	--	--	Kidney	--	--	--	--
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
	Exposure Medium Total							--					0.3
Medium Total								--					0.3
Receptor Total							Receptor Risk Total	--				Receptor HI Total	0.3

TABLE 9.7.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
SITES 3, 7, 14, 15, 18, AND 20 GROUNDWATER RECORD OF DECISION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Area A Weapons Center (Site 20)	Trichloroethene	--	--	2.1E-10	--	2.1E-10	NA	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	--	1.1E-09	--	1.1E-09	Skin, CVS	--	--	0.0002	0.0002
			Chemical Total	--	--	1.3E-09	--	1.3E-09		--	--	0.0002	0.0002
		Exposure Point Total						1.3E-09					0.0002
	Exposure Medium Total							1.3E-09					0.0002
	Groundwater	Area A Weapons Center (Site 20)	Trichloroethene	--	1.1E-08	--	--	1.1E-08	NA	--	--	--	--
			Benzo(a)pyrene	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	--	--	--	--	NA	--	--	--	--
			Chemical Total	--	1.1E-08	--	--	1.1E-08		--	--	--	--
		Exposure Point Total						1.1E-08					--
	Exposure Medium Total							1.1E-08					--
Medium Total								1.2E-08					0.0002
Receptor Total							Receptor Risk Total	1.2E-08				Receptor HI Total	0.0002

Total CVS HI	0.0002
Total Skin HI	0.0002

TABLE 9.8.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

SITES 3, 7, 14, 15, 18, AND 20 GROUNDWATER RECORD OF DECISION

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Area A Weapons Center (Site 20)	Trichloroethene	7.7E-07	–	8.5E-08	–	8.5E-07	NA	–	- -	–	–
			Benzo(a)pyrene	7.1E-06	–	- -	–	7.1E-06	NA	–	- -	–	–
			Arsenic	5.6E-05	–	1.3E-07	–	5.6E-05	Skin, CVS	0.3	- -	0.0007	0.3
			Chemical Total	6.4E-05	–	2.1E-07	–	6.4E-05		0.3	- -	0.0007	0.3
		Exposure Point Total						6.4E-05					0.3
	Exposure Medium Total							6.4E-05					0.3
	Groundwater	Area A Weapons Center (Site 20)	Trichloroethene	–	7.7E-07	–	–	7.7E-07	NA	- -	–	- -	–
			Benzo(a)pyrene	–	- -	–	–	- -	NA	- -	–	- -	–
			Arsenic	–	- -	–	–	- -	NA	- -	–	- -	–
			Chemical Total	–	7.7E-07	–	–	7.7E-07		- -	–	- -	–
		Exposure Point Total						7.7E-07					–
	Exposure Medium Total							7.7E-07					–
Medium Total								6.5E-05					0.3
Receptor Total							Receptor Risk Total	6.5E-05				Receptor HI Total	0.3

Note:

Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.

Total Skin HI	0.3
Total CVS HI	0.3

TABLE 9.1.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
SITES 3, 7, 14, 15, 18, AND 20 GROUNDWATER RECORD OF DECISION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 3	1,1,2-Trichloroethane	--	--	4.9E-11	--	4.9E-11	Blood	--	--	0.00002	0.00002
			Trichloroethene	--	--	1.7E-11	--	1.7E-11	Liver	--	--	0.00002	0.00002
			Vinyl Chloride	--	--	4.2E-10	--	4.2E-10	Liver	--	--	0.00001	0.00001
			Benzo(a)pyrene	--	--	9.1E-08	--	9.1E-08	NA	--	--	--	--
			Dibenzo(a,h)anthracene	--	--	3.2E-07	--	3.2E-07	NA	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	--	2.6E-08	--	2.6E-08	NA	--	--	--	--
			Alpha-BHC	--	--	6.2E-10	--	6.2E-10	NA	--	--	0.00001	0.00001
			Arsenic	--	--	1.6E-09	--	1.6E-09	Skin, CVS	--	--	0.0003	0.0003
			Chemical Total	--	--	4.4E-07	--	4.4E-07		--	--	0.0003	0.0003
		Exposure Point Total						4.4E-07					0.0003
	Exposure Medium Total							4.4E-07					0.0003
Medium Total								4.4E-07					0.0003
Receptor Total							Receptor Risk Total	4.4E-07				Receptor HI Total	0.0003

From Basewide Groundwater Operable Unit Remedial Investigation Update/Feasibility Study (TtNUS, 2004).

TABLE 9.2.CTE

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

CENTRAL TENDENCY EXPOSURE

SITES 3, 7, 14, 15, 18, AND 20 GROUNDWATER RECORD OF DECISION

NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age:	Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 3	1,1,2-Trichloroethane	1.9E-07	--	1.5E-08	--	2.0E-07	Blood	0.006	--	0.0005	0.007
			Trichloroethene	3.6E-08	--	5.2E-09	--	4.1E-08	Liver	0.004	--	0.0006	0.005
			Vinyl Chloride	2.4E-06	--	1.0E-07	--	2.5E-06	Liver	0.009	--	0.0004	0.009
			Benzo(a)pyrene	1.6E-06	--	2.9E-05	--	3.1E-05	NA	--	--	--	--
			Dibenzo(a,h)anthracene	3.6E-06	--	1.0E-04	--	1.1E-04	NA	--	--	--	--
			Indeno(1,2,3-cd)pyrene	4.2E-07	--	8.3E-06	--	8.7E-06	NA	--	--	--	--
			Alpha-BHC	2.9E-07	--	2.0E-07	--	4.9E-07	NA	0.0007	--	0.0005	0.001
			Arsenic	6.3E-05	--	1.5E-07	--	6.3E-05	Skin, CVS	1.1	--	0.003	1.1
			Chemical Total	7.1E-05	--	1.4E-04	--	2.1E-04		1.1	--	0.00	1.1
		Exposure Point Total						2.1E-04					1.1
	Exposure Medium Total							2.1E-04					1.1
	Groundwater	Site 3	1,1,2-Trichloroethane	--	1.9E-07	--	--	1.9E-07	Blood	--	0.006	--	0.006
			Trichloroethene	--	3.6E-08	--	--	3.6E-08	Liver	--	--	--	--
			Vinyl Chloride	--	2.4E-06	--	--	2.4E-06	Liver	--	0.009	--	0.009
			Benzo(a)pyrene	--	--	--	--	--	NA	--	--	--	--
			Dibenzo(a,h)anthracene	--	--	--	--	--	NA	--	--	--	--
			Indeno(1,2,3-cd)pyrene	--	--	--	--	--	NA	--	--	--	--
			Alpha-BHC	--	--	--	--	--	NA	--	--	--	--
			Arsenic	--	--	--	--	--	Skin, CVS	--	--	--	--
			Chemical Total	--	2.6E-06	--	--	2.6E-06		--	0.02	--	0.02
		Exposure Point Total						2.6E-06					0.02
	Exposure Medium Total							2.2E-04					1.1
Medium Total								2.2E-04					1.1
Receptor Total							Receptor Risk Total	2.2E-04				Receptor HI Total	1.1

Note:

Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.

From Basewide Groundwater Operable Unit Remedial Investigation Update/Feasibility Study (TtNUS, 2004).

Total Blood HI	0.01
Total CVS HI	1.1
Total Liver HI	0.02
Total Skin HI	1.1

TABLE 9.3.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
SITES 3, 7, 14, 15, 18, AND 20 GROUNDWATER RECORD OF DECISION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Torpedo Shops (Site 7)	1,3-Dichlorobenzene	- -	--	- -	--	- -	None Specified	--	- -	0.0009	0.0009
			1,4-Dichlorobenzene	- -	--	3.2E-10	--	3.2E-10	None Specified	--	- -	0.0010	0.0010
			Chlorobenzene	- -	--	- -	--	- -	Liver	--	- -	0.002	0.002
			Benzene	- -	--	2.5E-11	--	2.5E-11	None Specified	--	- -	0.00007	0.00007
			Trichloroethene	- -	--	1.7E-11	--	1.7E-11	Liver	--	- -	0.0003	0.0003
			Bis(2-ethylhexyl)phthalate	- -	--	2.1E-09	--	2.1E-09	Liver	--	- -	0.009	0.009
			Hexachlorobenzene	- -	--	9.8E-08	--	9.8E-08	Liver	--	- -	0.009	0.009
			Arsenic	- -	--	- -	--	- -	Skin	--	- -	--	--
			Barium	- -	--	- -	--	- -	CVS, Fetus	--	- -	--	--
			Chromium	- -	--	- -	--	- -	None Specified	--	- -	0.02	0.02
			Lead	- -	--	- -	--	- -	NA	--	- -	- -	--
			Vanadium	- -	--	- -	--	- -	None Specified	--	- -	0.005	0.005
			Chemical Total	- -	--	1.0E-07	--	1.0E-07		--	- -	0.05	0.05
		Exposure Point Total						1.0E-07					0.05
	Exposure Medium Total							1.0E-07					0.05
Medium Total								1.0E-07					0.05
Receptor Total							Receptor Risk Total	1.0E-07				Receptor HI Total	0.05

From Basewide Groundwater Operable Unit Remedial Investigation Report, TtNUS (2002a).

TABLE 9.4.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
SITES 3, 7, 14, 15, 18, AND 20 GROUNDWATER RECORD OF DECISION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Torpedo Shops (Site 7)	1,3-Dichlorobenzene	--	--	--	--	--	None Specified	0.008	--	0.03	0.03
			1,4-Dichlorobenzene	1.7E-07	--	1.0E-07	--	2.7E-07	None Specified	0.002	--	0.03	0.03
			Chlorobenzene	--	--	--	--	--	Liver	0.004	--	0.04	0.05
			Benzene	5.0E-08		6.7E-09		5.7E-08	None Specified	0.002	--	0.001	0.004
			Trichloroethene	3.5E-08		5.1E-09		4.0E-08	Liver	0.004	--	0.009	0.01
			Bis(2-ethylhexyl)phthalate	3.8E-07		6.7E-07		1.1E-06	Liver	0.01	--	0.3	0.3
			Hexachlorobenzene	7.3E-06		3.1E-05		3.9E-05	Liver	0.04	--	0.3	0.3
			Arsenic	4.3E-06		--		4.3E-06	Skin	0.07	--	--	0.07
			Barium	--	--	--	--	--	CVS, Fetus	0.008	--	--	0.008
			Chromium	--	--	--	--	--	None Specified	0.05	--	0.2	0.2
			Lead	--	--	--	--	--	NA	--	--	--	--
			Vanadium	--	--	--	--	--	None Specified	0.02	--	0.04	0.06
			Chemical Total	1.2E-05	--	3.2E-05	--	4.4E-05		0.2	--	0.8	1.1
		Exposure Point Total						4.4E-05					1.1
	Exposure Medium Total							4.4E-05					1.1
	Groundwater	Torpedo Shops (Site 7)	1,3-Dichlorobenzene	--	--	--	--	--	None Specified	--	0.008	--	0.008
			1,4-Dichlorobenzene	--	1.7E-07	--	--	1.7E-07	None Specified	--	0.002	--	0.002
			Chlorobenzene	--	--	--	--	--	Liver		0.004		0.004
			Benzene	--	5.0E-08	--	--	5.0E-08	None Specified		0.002		0.002
			Trichloroethene	--	3.5E-08	--	--	3.5E-08	Liver		0.004		0.004
			Bis(2-ethylhexyl)phthalate	--	--	--	--	--	Liver		--		--
			Hexachlorobenzene	--	--	--	--	--	Liver		--		--
			Arsenic	--	--	--	--	--	Skin	--	--	--	--
			Barium	--	--	--	--	--	CVS, Fetus	--	--	--	--
			Chromium	--	--	--	--	--	None Specified	--	--	--	--
			Lead	--	--	--	--	--	NA	--	--	--	--
			Vanadium	--	--	--	--	--	None Specified	--	--	--	--
			Chemical Total	--	2.5E-07	--	--	2.5E-07		--	0.02	--	0.02
		Exposure Point Total						2.5E-07					0.02
	Exposure Medium Total							2.5E-07					0.02
Medium Total								4.5E-05					1.1
Receptor Total							Receptor Risk Total	4.5E-05				Receptor HI Total	1.1

Note:
Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.
From Basewide Groundwater Operable Unit Remedial Investigaiton Report, TtNUS (2002a).

Total Skin HI	0.07
Total Liver HI	0.7
Total CVS HI	0.008
Total Fetus HI	0.008
Total None Specified HI	0.3

TABLE 9.5.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
SITES 3, 7, 14, 15, 18, AND 20 GROUNDWATER RECORD OF DECISION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 15	Cadmium	- -	--	- -	--	- -	Kidney	--	- -	0.0005	0.0005
			Chemical Total	- -	--	- -	--	- -		--	- -	0.0005	0.0005
		Exposure Point Total						- -					0.0005
	Exposure Medium Total							- -					0.0005
Medium Total								- -					0.0005
Receptor Total							Receptor Risk Total	- -				Receptor HI Total	0.0005

TABLE 9.6.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
SITES 3, 7, 14, 15, 18, AND 20 GROUNDWATER RECORD OF DECISION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 15	Cadmium	--	--	--	--	--	Kidney	0.1	--	0.005	0.1
			Chemical Total	--	--	--	--	--		0.1	--	0.005	0.1
		Exposure Point Total						--					0.1
	Exposure Medium Total							--					0.1
	Groundwater	Site 15	Cadmium	--	--	--	--	--	Kidney	--	--	--	--
			Chemical Total	--	--	--	--	--		--	--	--	--
		Exposure Point Total						--					--
From Basewide Groundwater Ope	Exposure Medium Total							--					0.1
Medium Total								--					0.1
Receptor Total							Receptor Risk Total	--				Receptor HI Total	0.1

TABLE 9.7.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
SITES 3, 7, 14, 15, 18, AND 20 GROUNDWATER RECORD OF DECISION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Area A Weapons Center (Site 20)	Trichloroethene	--	–	7E-11	–	7E-11	NA	–	--	–	–
			Benzo(a)pyrene	--	–	--	–	--	NA	–	--	–	–
			Arsenic	--	–	3E-10	–	3E-10	Skin, CVS	–	--	0.00004	0.00004
			Chemical Total	--	–	3E-10	–	3E-10		–	--	0.00004	0.00004
		Exposure Point Total						3E-10					0.00004
	Exposure Medium Total							3E-10					0.00004
	Groundwater	Area A Weapons Center (Site 20)	Trichloroethene	–	3E-09	–	–	3E-09	NA	--	–	--	–
			Benzo(a)pyrene	–	--	–	–	--	NA	--	–	--	–
			Arsenic	–	--	–	–	--	NA	--	–	--	–
			Chemical Total	–	3E-09	–	–	3E-09		--	–	--	–
		Exposure Point Total						3E-09					–
	Exposure Medium Total							3E-09					–
Medium Total								3E-09					0.00004
Receptor Total							Receptor Risk Total	3E-09				Receptor HI Total	0.00004

Total CVS HI	0.00004
Total Skin HI	0.00004

TABLE 9.8.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
SITES 3, 7, 14, 15, 18, AND 20 GROUNDWATER RECORD OF DECISION
NSB-NLON, GROTON, CONNECTICUT

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Area A Weapons Center (Site 20)	Trichloroethene	1.1E-07	--	1.4E-08	--	1.2E-07	NA	--	- -	--	--
			Benzo(a)pyrene	6.0E-07	--	- -	--	6.0E-07	NA	--	- -	--	--
			Arsenic	7.9E-06	--	1.7E-08	--	7.9E-06	Skin, CVS	0.1	- -	0.0003	0.1
			Chemical Total	8.6E-06	--	3.1E-08	--	8.7E-06		0.1	- -	0.0003	0.1
		Exposure Point Total						8.7E-06					0.1
	Exposure Medium Total							8.7E-06					0.1
	Groundwater	Area A Weapons Center (Site 20)	Trichloroethene	--	1.1E-07	--	--	1.1E-07	NA	- -	--	- -	--
			Benzo(a)pyrene	--	- -	--	--	- -	NA	- -	--	- -	--
			Arsenic	--	- -	--	--	- -	NA	- -	--	- -	--
			Chemical Total	--	1.1E-07	--	--	1.1E-07		- -	--	- -	--
		Exposure Point Total						1.1E-07					--
	Exposure Medium Total							1.1E-07					--
Medium Total								8.8E-06					0.1
Receptor Total							Receptor Risk Total	8.8E-06				Receptor HI Total	0.1

Total Skin HI	0.1
Total Liver HI	0.1

Note:
Inhalation exposures are assumed to be equal to the exposures from ingestion of groundwater.

APPENDIX G

SELECTED REMEDY COST ESTIMATE

NSB-NLON
GROTON, CONNECTICUT
SITES 3 AND 7 GROUNDWATER (Alternatives GW 1-2 and GW 2-2)
NATURAL ATTENUATION WITH MONITORING AND INSTITUTIONAL CONTROLS
Present Worth Analysis for Record of Decision

Year	Sites 3/7 - Alt. GW 1-2 Capital Cost	Sites 3/7 - Alt. GW 1-2 Annual Cost	Site 7 - Alt. GW2-2 Capital Cost	Site 7 - Alt. GW2-2 Annual Cost	Total Year Cost	Annual Discount Rate at 3.2%	Present Worth
0	$59,189		$59,713		$118,901	1.000	$118,901
1		$51,212		$49,264	$100,476	0.969	$97,360
2		$16,378		$14,441	$30,819	0.939	$28,937
3		$16,378		$14,441	$30,819	0.910	$28,040
4		$16,378		$14,441	$30,819	0.882	$27,171
5		$41,378		$39,441	$80,819	0.854	$69,042
6		$1,000		$1,000	$2,000	0.828	$1,656
7		$1,000		$1,000	$2,000	0.802	$1,604
8		$1,000		$1,000	$2,000	0.777	$1,555
9		$1,000		$1,000	$2,000	0.753	$1,506
10		$41,378		$39,441	$80,819	0.730	$58,982
11		$1,000		$1,000	$2,000	0.707	$1,414
12		$1,000		$1,000	$2,000	0.685	$1,370
13		$1,000		$1,000	$2,000	0.664	$1,328
14		$1,000		$1,000	$2,000	0.643	$1,287
15		$41,378		$39,441	$80,819	0.623	$50,387
16		$1,000		$1,000	$2,000	0.604	$1,208
17		$1,000		$1,000	$2,000	0.585	$1,171
18		$1,000		$1,000	$2,000	0.567	$1,134
19		$1,000		$1,000	$2,000	0.550	$1,099
20		$41,378		$39,441	$80,819	0.533	$43,045
21		$1,000		$1,000	$2,000	0.516	$1,032
22		$1,000		$1,000	$2,000	0.500	$1,000
23		$1,000		$1,000	$2,000	0.485	$969
24		$1,000		$1,000	$2,000	0.470	$939
25		$41,378		$39,441	$80,819	0.455	$36,772
26		$1,000		$1,000	$2,000	0.441	$882
27		$1,000		$1,000	$2,000	0.427	$854
28		$1,000		$1,000	$2,000	0.414	$828
29		$1,000		$1,000	$2,000	0.401	$802
30		$56,340		$49,135	$105,475	0.389	$40,997
						TOTAL PRESENT WORTH	$623,275

SITE 23
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
ALTERNATIVE 3-2: INSTITUTIONAL CONTROLS
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING											
1.2 Prepare LUC RD Documents	150	hr			$35.00		$0	$0	$5,250	$0	$5,250
Subtotal							$0	$0	$5,250	$0	$5,250
Local Area Adjustments							100.0%	96.6%	105.0%	105.0%	
							$0	$0	$5,072	$0	$5,072
Overhead on Labor Cost @ 30%									$1,521		$1,521
G & A on Labor Cost @ 10%									$507		$507
G & A on Material Cost @ 10%								$0			$0
G & A on Subcontract Cost @ 10%							$0				$0
G & A on Equipment Cost @ 10%										$0	$0
Total Direct Cost							$0	$0	$7,100	$0	$7,100
Indirects on Total Direct Cost @ 35%											$2,485
Profit on Total Direct Cost @ 10%											$710
Subtotal											$10,295
Health & Safety Monitoring @ 0%											$0
Total Field Cost											$10,295
Contingency on Total Field Costs @ 0%											$0
Engineering on Total Field Cost @ 0%											$0
TOTAL COST											**$10,295**

SITE 23
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
ALTERNATIVE 3-2: INSTITUTIONAL CONTROLS
ANNUAL COST

Item	Item Cost Year 1	Item Cost Years 2 and 3	Item Cost Years 4 and 5	Item Cost Years 6 through 30	Item Cost Every 5 Years	Notes
Inspection	$1,000	$1,000	$1,000	$1,000		Annual LUC inspection (assume 8 hours at $50/hr plus expenses)
Site Review					$25,000	5-year review
TOTALS	$1,000	$1,000	$1,000	$1,000	$25,000	

SITE 23
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT
ALTERNATIVE 3-2: INSTITUTIONAL CONTROLS
PRESENT WORTH ANALYSIS

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 3.2%	Present Worth
0	$10,295		$10,295	1.000	$10,295
1		$1,000	$1,000	0.969	$969
2		$1,000	$1,000	0.939	$939
3		$1,000	$1,000	0.910	$910
4		$1,000	$1,000	0.882	$882
5		$26,000	$26,000	0.854	$22,204
6		$1,000	$1,000	0.828	$828
7		$1,000	$1,000	0.802	$802
8		$1,000	$1,000	0.777	$777
9		$1,000	$1,000	0.753	$753
10		$26,000	$26,000	0.730	$18,980
11		$1,000	$1,000	0.707	$707
12		$1,000	$1,000	0.685	$685
13		$1,000	$1,000	0.664	$664
14		$1,000	$1,000	0.643	$643
15		$26,000	$26,000	0.623	$16,198
16		$1,000	$1,000	0.604	$604
17		$1,000	$1,000	0.585	$585
18		$1,000	$1,000	0.567	$567
19		$1,000	$1,000	0.550	$550
20		$26,000	$26,000	0.533	$13,858
21		$1,000	$1,000	0.516	$516
22		$1,000	$1,000	0.500	$500
23		$1,000	$1,000	0.485	$485
24		$1,000	$1,000	0.470	$470
25		$26,000	$26,000	0.455	$11,830
26		$1,000	$1,000	0.441	$441
27		$1,000	$1,000	0.427	$427
28		$1,000	$1,000	0.414	$414
29		$1,000	$1,000	0.401	$401
30		$26,000	$26,000	0.389	$10,114
				TOTAL PRESENT WORTH	$118,998